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THE MAXIM MACHINE GUN.

AT this stage in the development of machine gun fire no new design is likely to meet with much attention unless there is something very striking and promising in it. The machine guns already in use have been so far perfected in their working that nothing now entering the field is likely to overtake them and compete successfully with them on their own lines. To hope for success or, we might almost say, to hope for much opportunity of competition, an inventor must put forward fundamental advantages in principle such as can be shown sufficient to promise very decided superiority over the guns that have already found their way into existing armaments, and which will not readily be displaced. On this ground, and nothing less, must a machine gun now brought forward by Mr. Maxim, to be seen at 57D Hatton Garden, stand. Our readers can judge for themselves of the probability of the principles embodied in it proving successful in practice. As to their originality and ingenuity in conception, we think there cannot be two opinions.

In machine guns hitherto tried, the feeding and firing and the traversing have to be performed by manual power, and, however beautifully carried out, the operator in any competition for speed is pretty severely tried; and one operator alone can hardly manipulate the machine at high speed, and in his breathless condition alter its direction to any purpose. Of course, the assistance of another man must be had when the particular magazine from which the rounds are entering the gun is exhausted.

Mr. Maxim, therefore, in his machine, claims to have achieved a remarkable advance in making the recoil of his barrels work the feeding and firing gear; the operator kneels down quietly behind the breech, and directs the barrel at his leisure exactly as he likes. There are clearly more advantages in this than appear at once. First, as noticed above, the heavy work of manipulation is saved; secondly, the danger of a jamb from a delay or hang fire is obviated, for the obvious reason that, as it is the shock of discharge of each round that loads and fires the succeeding one, when a cartridge hangs fires, the gun must wait for it, as without it there is no motive power to load the next round. This is clearly a very different condition of things from that in other machine guns, when a man is driving the loading and firing gear as hard as his strength permits, and when a jamb may be produced by delay; thirdly, a much greater rate of firing may be attained than by hand-driven gear, viz., 600 rounds per minute instead of about 200; fourthly, the machine may be much lighter, and need not be clamped rigidly, as must be the case when a lever handle has to be violently worked on one side of it.

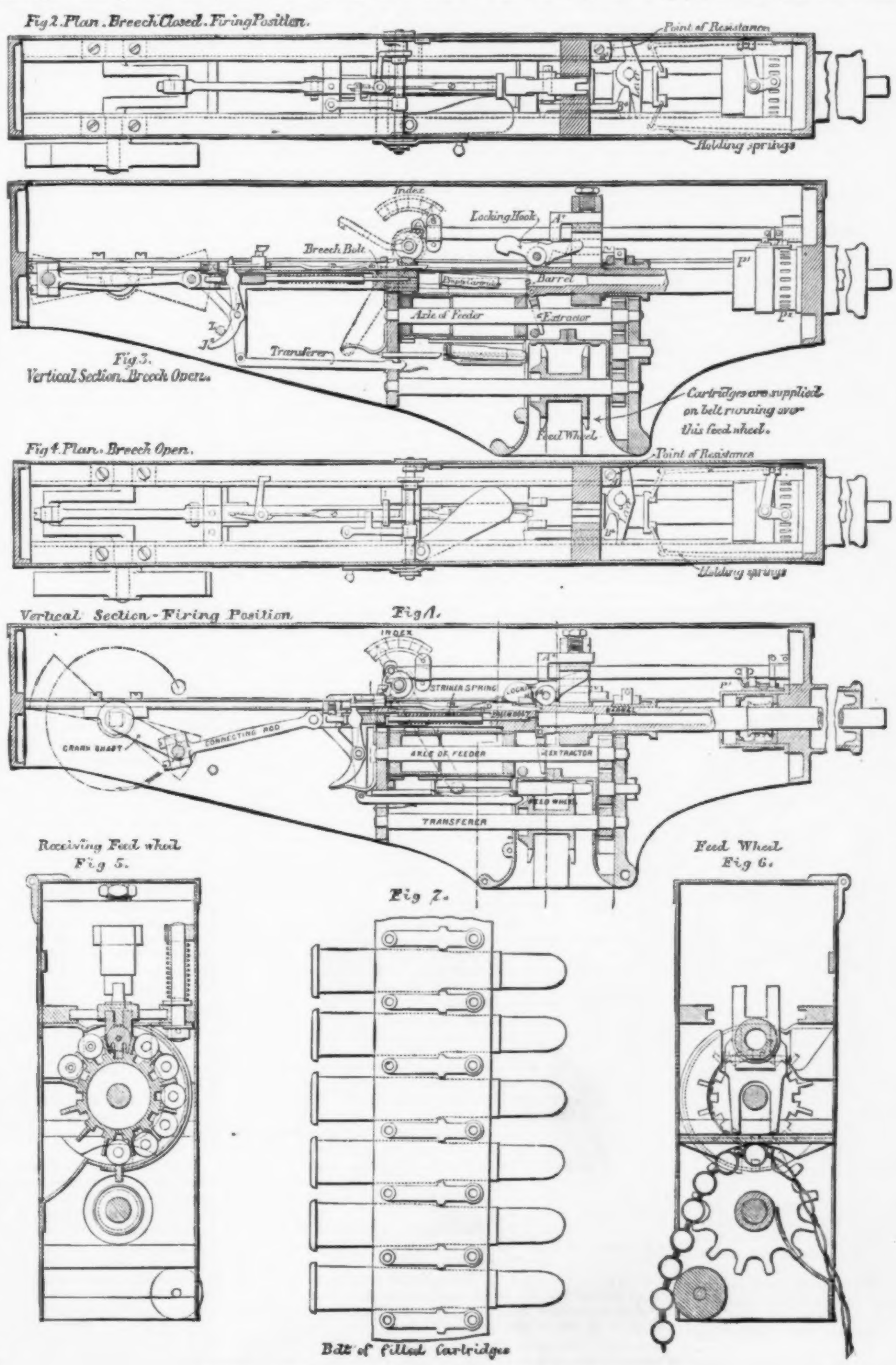
The gun may be described as follows: It has a single barrel, arranged in such a way as to recoil slightly in its bearings, the force of recoil of each round acting on the feeding and firing gear, so as to load and discharge the next round, and so on, round after round in succession. That is, the force of recoil extracts and ejects the empty case, brings the next round into position, pushes it home, and cocks and liberates the striker. The barrel recoils $\frac{7}{8}$ in., with its breech held firmly closed. This gives the bullet time to escape, and fly about 100 ft., so that the gases have also abundant time to escape after it has left the muzzle. Then a locking hook, which has held it close, is opened, and the barrel is stopped, while the breech and extractor run on, carrying the empty case with them. This is ejected, and the succeeding round brought into position by a feed wheel, when the return stroke, given by a connecting rod, sends the charge home, closing the breech, pushing the barrel forward into the firing position, and finally releasing the striker which fires the round. The recoil of this round repeats the above movements, and so on, as long as filled cartridges are supplied and fired. Mr. Maxim has made his gun with a 0·45 in. bore to fire the service cartridges. He has a pattern of cartridge case which enables him to have a much simpler gun, because he is able to dispense with the recoil of the barrel proper and work with the breech recoil alone; but Mr. Maxim thinks it wiser to sacrifice what is necessary to enable him to meet all existing conditions. The gun without stand weighs about 60 lb., a tripod stand for a man-of-war about 130 lb., and a carriage for field service from about 60 lb. to 200 lb., according to the requirements of the case. This tripod is about 3 ft. high, and the piece from muzzle to rear of firing mechanism measures about 4 ft. 9 in. The gun can be left to move freely by hand for rapid change of position, as in the case of torpedo boats or cavalry at short distances; or it may be clamped and traversed or elevated by slow or quick movement screws. The cartridges are fed either from a belt or a drum. The belt is preferred by many; General Sir G. Graham, R.E., we believe for one. Each band or belt is about 7 ft. long, and carries 333 cartridges, and one belt can be joined on to another, so that a stream of indefinite length can be used with care and attention in placing the boxes containing each belt in position. The drum fits on to the top, and is, we think, a more ordinary and less complete arrangement; it only holds 96 cartridges, also, and a man would be much more likely to be exposed in changing drums than in arranging the belts, and he would be kept constantly employed; in fact, one man does not appear to be at all sufficient for the work in rapid firing. When at full speed—600 per minute—allowing the bullets a velocity of 1,200 ft. per second, it will be seen that a stream of bullets is formed, 150 ft. from bullet to bullet. Should all the men near the piece be killed, the gun will go on firing as long as the supply of ammunition lasts. Under these conditions, the barrel must become very violently heated. Some of our readers are perhaps familiar with the spectacle of machine gun barrels firing at a much lower rate of speed passing through the different tempering colors of steel. Mr. Maxim endeavors to provide for this by inclosing the barrel in an outer gun-metal case, which allows a large space between barrel and case to be filled with water. Finally, he has devised a plan for carrying the smoke off from the muzzle.

The natural objections that appear to suggest themselves are: (1) That the opening of the breech by recoil is difficult to manage safely at so great a rate. We think, however, if it is clearly understood that the breech must remain completely closed—indeed, no more opening than any breech-loading cannon during recoil—until it has reached a point when the bullet is 100 ft. away, it will be seen that there is no danger of escape of gas. We should be rather curious to see what would happen if a bullet lodged in the bore; but this is an awkward contingency for any machine gun. (2) It may be objected that a misfire stops the firing for the moment, while in many machine guns it merely involves the failure of one bullet, the cartridge being ejected and the firing going on without interruption. We are sorry to say that this very obvious objection did not occur to us while inspecting the gun, so we have not given Mr. Maxim an opportunity of answering it. Perhaps the machine can be sent on by hand instantly; but we think cartridges for this gun ought to be as free from misfires as possible, as the loss of a number of rounds delivered in quick firing must be serious.

Altogether, we think the gun a wonderful design, and one which naturally attracts much greater interest than almost any piece in the same stage of development. The speed of firing, the ease of working, and saving of exposure of men, promise great practical advantages, and the extreme neatness of the idea of the automatic system, by which each round fires itself and works the gear at exactly the speed that suits its own behavior, is very attractive.

The engraving shows the mechanism and action of the gun, which, as described above, when loaded and fired, continues the process of loading and firing and feeding itself as long as a supply of cartridges is presented to it. The form of supply recommended consists in bands or belts, each holding 333 rounds, which can be hooked on to each other so as to keep up a continuous supply.

The gun can be set to fire at any rate up to 600 rounds per minute. The action is as follows: On firing, the barrel and breech bolt—see Figs. 1 and 3—with attachments recoil, firmly held together by the locking hook, for about 0·44 in., then the



THE NEW MAXIM AUTOMATIC GUN.

counter lever of the latter comes in contact with the block, A_4—Figs. 1 and 3—causing the hook to rise and release the breech bolt, which at the same time receives a sudden impetus from the lever—see Figs. 2 and 4—whose counter lever is brought in contact with the point of resistance on the piece, A_4, causing the lever to act against B_4, and so drive back the breech bolt and its attachments. It may be observed that this point of resistance moves along the curved face of A_4, changing each instant from a lever of greater power to one of greater speed; thus the momentum of the barrel is suddenly transferred to the breech bolt and its attachments, which fly back with sufficient force to complete a revolution of the crank and connecting rod, bringing the breech block back to the barrel, and forcing both home into the firing position. In the mean time the extractor—Figs. 1 and 3—is made to eject the empty case of the fired cartridge—Fig. 3. The transferer at the same time draws a filled cartridge back from the feed wheel, which is carrying round the belt full of cartridges, and leaves it in the feeder—Figs. 2 and 3. The feeder is made to revolve, bringing a filled cartridge round in the place of the empty one, in time to be carried forward by the advance of the breech bolt. Also near the end of the withdrawal stroke the counter lever, J_2, of the lever, J_1 J J_2—Figs. 1 and 3—comes in contact with the stop, L, which causes the lever end, J_1, to carry back the striker and cock it.

Of course there are many pieces of mechanism not dealt with in this general explanation—for example, the arrangement for setting the gear for quick or slow firing—which depends on the opening or shutting off of the lever at the index and valves in a hydraulic cylinder—P_1 P_2 in Figs. 1 and 3—the gear for revolving the feed wheel, and many minor details. The general character of the action may, however, be seen from the above. The adjustment of the levers and counter levers for speed or power, and the transferring of momentum, is, perhaps, the neatest part of the design. As stated in the descriptive article, September 26, the work would be greatly simplified if a special cartridge could be employed rendering the movement of the barrel unnecessary. Mr. Maxim has made many modifications of his design; ten forms of it are briefly described and illustrated in his patent specifications.—*The Engineer.*

TRAINING FOR MECHANICAL ENGINEERS.*

By PROF. G. I. ALDEN.

PROGRESS in education is largely secured by forces lifting from above rather than pushing from below. A sense of ignorance will not create the means for removing it. It may stimulate effort to secure such means, but until some minds have grasped principles, comprehended mental processes, moulded truth into forms suited to the comprehension and assimilation of the average mind, and devised methods of stimulating a desire for truth, there can be but little general progress.

The higher schools, as we know, keep up the standards of the lower. A college started on a broad plan, with high aims, the conception of a gifted and trained mind, and administered by men in sympathy with its plan, raises the standard of scholarship in every preparatory school within the range of its influence. A school does not therefore grow from vital forces within itself into a perfect system of education. It can only hope to become in this way perfect of its kind. It will evolve by growth only that which is latent in the germ. Knowledge incomprehensible to its teachers, attainments of which they have never dreamed, results which the plan of the school does not compass, are not its legitimate fruit, and therefore not to be expected of it. The progress of events does not wait for the education of the many. When a few have made great discoveries in science or produced sublime works of art, or constructed wonderful and efficient agencies for the comfort and good of mankind, *they* have set the standard, and until it is reached, that standard, so far as it is comprehended, becomes the aim of educators in science, in art, in engineering.

Mechanical engineering, as taught in the schools, is no exception to the general law. As a liberal profession it is taking a high rank. It covers a field broad enough to give scope to the best powers and ambitions of young men who enter it. It offers the rewards of constantly increasing mental development, a consciousness of power to make matter and force subservient to the progress of civilization and the highest good of mankind, and assured self support by useful and ennobling effort. But it holds this place and looks for its future progress to two attracting and uplifting forces, viz., *scientific attainments* and *practical achievements.* To these forces, inherent in the expressed thought and accomplished work of men foremost in engineering science and practice, the schools must look for effective stimulus to progress. When two forces act in the same direction along parallel lines, their resultant is a maximum, and this resultant is increased by whatever is added to either force.

If beside being parallel the forces are applied at the same point, the separate forces as such disappear, both being coincident with the maximum resultant. The man who, by education and experience, possesses these two forces in their highest magnitude and best combination is the successful and accomplished engineer. The product of the engineering school should be trained to grow into his likeness. A school for training engineers is properly a professional school. Its students ought therefore to enter with as broad and thorough general training as it is possible for them to secure. To this all agree. But until it is possible to get in candidates the desired breadth of liberal training, it is unwise to attempt to meet the criticisms of narrowness in the engineering course by introducing the so called liberal studies. The time will not permit it without serious detriment to the main object of the school. A better remedy is to hold up the engineering course to such a standard as to secure the professional practical efficiency of the graduates, and, having shown that the engineering course leads to something worth reaching, demand suitable preparation for matriculation. By this means two great ends are ultimately gained, by the other neither is fully secured. The school on the one hand lowers its standard of professional training, or on the other cannot compete with the many institutions devoted wholly to teaching general studies.

But leaving this point with the single suggestion just made, and assuring the professional character of the engineering school, let us consider the ends which it must aim to secure in order to meet the growing demands of the profession.

What are the eminent engineers of to-day desiring for the young men who enter their ranks through the schools? What do you hope for in those who are to work in your employ, build and help perfect your designs, and finally take up your grand unfinished work and carry it forward into the next century of progress? It is in the hope of drawing out in discussion your ideas upon these questions that I venture to suggest some ends at which the schools should aim, and some methods by which this aim may be accomplished. The school training ought to lay the sure foundations for the scientific attainments and the ability for practical achievements which combined characterize the engineer. It is not enough to aim at securing practical achievements. An essential end of training even in a professional school, is the right development of the man. In the words of an eminent English author, "Man himself is the crowning wonder of creation; and to his advancement all undertakings, all professions, all arts, all knowledge, all institutions, are subordinate as means and instruments to their end." Scientific attainments are not alone the sufficient aim of the school. The acquirement of ability to use such attainments as means to practical ends is as broadening to the faculties, as exacting to thought, as valuable in the development of the individual, as it is necessary to usefulness and success in professional pursuits. These two ends, naturally so closely allied, I shall for convenience first consider separately.

The scientific attainments necessary to the engineer are more than knowledge of facts and principles. The proof of such attainments is the ability, within a sufficiently wide range of inquiry, to give accurate answers to definite questions; to solve engineering problems by the best and most direct methods; to originate and properly conduct investigations and experiments relating to the many questions which constantly arise in engineering design and construction. To secure such attainments the school first gives the student instruction in mathematics, applied mechanics, physics, chemistry, and drawing; and in modern languages for discipline and culture, and as a means of access through scientific publications to the current thought and work of the profession. By judicious selection of topics in all the branches of study, and by constant drill in the application of each principle or process taught to the solution of problems, on paper or experimentally in laboratories, every step is made to bear upon the end in view, and to facilitate the use to be made of the knowledge acquired. The methods of teaching must be direct, thorough, always grounding the student firmly upon a few rock principles, upon which he builds securely, and to which he is constantly compelled to refer all his work. Little time can be afforded, especially in the earlier stages of this work, for the student to go over by himself the processes by which laws have been discovered, truths demonstrated, and principles established.

In this way a teacher, who should exercise his ingenuity to keep the student busy rather than to advance his knowledge, might consume his whole time in teaching the merest rudiments of his subject. The forms in which the truths of science are presented to the mind are being constantly simplified, and are thus more easily grasped. Crystallized around a few great principles, we study the crystal and comprehend its beauty and value without individually crystallizing the gem out of the river of error from which it was primarily obtained. Original investigations for the discovery of laws or the solution of special unsolved problems can be made with most profit and success when we have comprehended by the most direct means the work already accomplished by our eminent predecessors in the field. In the study of applied physics and mechanics the drill in the solution of well chosen problems is still indispensable. The problems here involve more elements. Their solution requires several steps, and calls for the use of the student's acquired knowledge of scientific principles and mathematical processes; of qualities and properties of materials, of transformation and conservation of energy, the efficiency of motors, the use of apparatus for accurate measurement and experimental research. I allude to these familiar topics in the curriculum of every engineering course to emphasize a single point, which is this: in teaching these subjects there is an end to be sought beyond the mere acquisition on the part of the student of separate abstract facts and principles. It is that ability and confidence in the use of acquired knowledge which, analyzing the problem, discerns the requirements for its solution, and then selects, chooses and adapts known principles and methods to the end in view. Many students will solve a problem without being told how to do it, provided they are asked a few questions. They know all the separate steps, but do not seem to be able without much practice to see the relations of these steps to one another and to the problem, and to go forward. It is for improvement in the efficiency of teaching in this field that physical and mechanical laboratories are made effective, that the solution of actual engineering problems is undertaken, and practical methods from beginning to end, and accurate results verified by careful comparisons with standard authorities are insisted upon.

It is by work of this kind that the student is introduced to the field of experience, that bookishness, impracticability, and inefficiency are in a degree removed before the student leaves the school. Success here vitalizes the whole training, and secures that complete assimilation and personal appropriation of the subjects taught throughout the course, which is the characteristic of the scientific attainments toward which the school should aim. The practical achievements of engineering are represented by the various mechanical agencies which engineering success has contributed for the use of man; the machines through which energy is made available for reducing the ores and minerals taken from the earth; for gathering and preparing its vegetable products for sustenance and comfort of man; for means of travel by sea and land, and for the swift flight and expression of thought from continent to continent. These machines are, generally speaking, all made in a machine shop. The designs of the engineer must be sent in intelligible form to the shop before the product of his brain can become the servant of his hand. The close relation which the machine shop bears to both the scientific attainments and practical achievements of the engineer is strikingly obvious. The machine shop is an institution in itself. It has its own methods and processes, its standards of machine design and workmanship, its tools and facilities. It has been developed by long experience. It has been improved by untiring effort. It has struggled with its own peculiar difficulties and obstacles, and its progress has set bounds to the practical achievements of engineering science.

Forms which the mind conceives in a moment, it has had the tedious and laborious work of executing in metal; subtle qualities of matter whose effects may escape the thought of the designer are certain to obstruct the progress of the mechanic; perfection of form and precision of motion which the mind conceives, it may be impossible more than to approximate in actual practice.

It seems clear, then, that the engineer or designer, in order to properly prepare his work for the shop, must know the shop methods, limitations, and possibilities.

While the schools have always aimed to teach drawing as a recognized means of presenting ideas to the shop, it has been found difficult, as might expected, to make good drawings for the shop without a knowledge of machine shop practice. The attainments of graduates from the schools have by some been set aside as worse than useless; as unfitting them for success, because at this vital point in practical work they were so eminently impractical.

By all it has been felt that the schools might and ought to do something to supply a deficiency so fully realized. This has been attempted. By general consent a shop department has become a recognized element in the engineering course of nearly every technical or polytechnic school. Of the methods and results of instruction in these shops, the practical engineers of the country are eminently fitted to judge. I therefore ask your most careful attention to a brief consideration of the questions, What should such a shop be, and what should it do? The object of the shop department is to supply to the school a new means of instruction in practical mechanical and engineering work. It is made a department in the school in order to add to the school methods as well as to its facilities of instruction. The shop, therefore, should not be such a department as would be developed by or out of the school by those who never had experience in shop work. A room fitted with machinists' tools, where curious things are made by odd processes for no purpose but the practice of making them, is not a machine shop in any practical sense. The school shop should be superior in all its appointments. It should not only have the tools, methods, and facilities, but also the skilled workmen and the business of a first class shop. All these, together with additional employes to act as instructors, should be turned to one object, viz., the advancement of the students in knowledge and skill. Only in this way can the shop yield its full benefit as a department of the school. It would be no discredit to such a shop, or to the school of which it forms a part, if under the stimulus and in the atmosphere of science it should produce better machines, adopt leading and improved practical methods, and set higher standards of practical excellence in the machine shop practice; if it should make its practice more scientific and its science more practical than the best manufacturing shops elsewhere. If this should not be an easy thing to do it would certainly seem within the limits of possibility.

To aim at anything less than the best practice of the leading manufacturing shops is to defeat one of the main objects of the shop department, and one of the special aims which, in some cases at least, has led to the establishment of the department.

One argument for the truth of this statement is the fact that such a shop is able to adopt in full measure the methods of teaching which, in other departments, the best teachers are advocating and practicing as far as their facilities will permit.

The anatomist desires for his class a real human limb or body for dissection. The teacher of natural history wants a collection of live animals for illustration. The chemist likes to get real commercial work for his special students, and to manufacture in the laboratory, on as large a scale as convenient, samples of pure and commercial chemicals. The physicist gets full sized working machines for his laboratory: dynamos, electric lights, testing machines, dynamometers, suited for actual use, and used for practical purposes. The mining engineer locates his school within easy access of the mines. How, then, can a school for teaching engineering afford to have in its practical department anything less than a real, productive machine shop?

Again, these real methods so generally adopted are in accordance with the economical principle of education, viz., that knowledge is gained most rapidly and thoroughly when analysis and synthesis are taught together. To require the mind to store away isolated facts, as crude material to be called up for future use, is an unnecessary tax.

The method of committing to memory the whole Latin grammar as a preliminary to the study of the Latin language is pretty much abandoned. Children are taught words before they know the letters of which the words are composed. These modern methods of education have been arrived at after long experiment, and are doubtless in the right general direction.

Because instruction in machine shop and engineering practice is comparatively new, shall we begin by an educational method which is generally abandoned? Certainly not. The sound principle should be applied and followed from the start. Let me briefly outline the two methods to which I have referred, as applied to instruction in mechanical and engineering practice.

Following the method of teaching analysis separate from synthesis, we should say that machine shop practice consists in performing certain operations with machines and tools; that by careful analysis, and the actual performance of these operations upon isolated pieces, the student will have learned the use of tools in all the necessary shop operations. Some time he may be called upon to make a machine, and then all this skill and knowledge thus acquired will be valuable. This is the plan which, we have seen, is largely abandoned in other subjects, and uneconomical in principle. Adopting the method of combining in the instruction both analysis and synthesis, we should say that a certain machine required in its construction the processes we desire at present to teach. It also represents the approved standards of design and workmanship for that class of machinery, and possesses a fitness and adaptation of parts which fixes a certain requirement in their production. The machinery itself is an object of interest to a boy of mechanical tastes, and its operation is to him a delight and an inspiration.

We give the student a part in the work of constructing this machine, a part requiring such tools and methods as his attainments permit. He is taught the analysis of each process he is to undertake, and is at once set about to work. The instruction is fresh in his mind; he is impressed with a feeling of responsibility, and stimulated by the end in view. It is reasonable that real work on an ingenious, well designed, and useful product should be a stimulus to effort and enthusiasm.

But the advantage which is gained by doing real practical work is by no means confined to economy of time in the requirement of skill and stimulus to enthusiastic endeavor. It has valuable elements of training which are not included, in so large a degree, in the method of teaching processes by work on isolated and useless pieces. It cultivates practical judgment, by introducing more elements of thought and more conditions into each problem. The part of a machine cannot be intelligently made without thinking and knowing about other parts which it is to fit and supplement.

Often a good knowledge of the construction and operation of a whole machine will be acquired by the student while he is making and fitting one piece. He studies the drawings to see that his own work is consistent with the

* Read before the American Association for the Advancement of Science, Philadelphia, Sept. 5, 1884.

completed product. It must be harmonious in style, material, and quality of workmanship, as well as have a definite size and form; and the standard for the machine as a whole is that set by the best manufacturers and engineers. Much of this training of the practical judgment would not be secured if the same piece had been made to size and form by rule and gauge alone.

Practical work in a real shop gives the student a degree of valuable experience. He works with skilled mechanics such as he will meet in other shops. He gets some of their ideas which have been acquired by long experience fairly lodged in his mind. He is obliged to respect their ways of doing things or else suggest better ones. He feels more responsibility and more pressure to get his work right, if he knows that it is to be really made use of. He is more willing to remedy what he would otherwise deem a slight mistake, or to repeat his work if wholly wrong, when be sees the degree of perfection necessary to the successful completion of a valuable machine. Such work in a shop results not only in skill, but in the kind of skill which practical foremen and superintendents recognize as valuable; a skill available because of the practical judgment and experience which have been simultaneously acquired. It is clear that such a shop as I have outlined must have a business, and that its superintendent must be a thorough practical mechanic and a good business manager. The business of such a shop should give variety of work. It should not, for the best results, be confined to the manufacture of a few things which give practice in routine work—though this is important—but should, if possible, include work of an engineering character, carried on and completed under all the exactions and requirements of contract work.

The high standards of practical achievements which should characterize the shop department are kept up by the requirements of the open market. Machines which are sold at the highest current prices must be as good as the best. If sold they will not be criticised with charity for the institution or for the students, but from the merciless standpoint of competition, or the just consideration of business equity. While the productive capacity of the shop in proportion to its current expenses is diminished by the instruction given to students—especially when the proportion of students to skilled workmen is large—the quality of the shop products need not and must not be lowered.

Summarizing briefly, we say that the shop for instruction of students in engineering should be a complete, well equipped machine shop, with the necessary pattern room, draughting rooms, forging and moulding shops, with unusual facilities for experimental work on mechanical problems; and should be administered by a skilled and competent superintendent and a corps of suitable instructors and journeymen. Turning to the question, What will such a department accomplish? I reply:

First.—It will stimulate to breadth and thoroughness of instruction in the theoretical studies of the course. If the shop department is carried on as an integral part of the school, and fully in sympathy with the aim of high scientific attainments, any failure of the theoretical instruction to furnish means for the solution of practical problems that arise in the engineering work of the shop will be felt, and as far as possible remedied. The shop department will raise rather than lower the standard of scientific attainment in the school, because such attainment is not likely to be in excess of the practical demands and opportunities which the shop operations make and offer.

Second.—It will give students who spend in the shop about ten hours per week for the entire course, a good general knowledge of the best machine shop practice, sufficient to serve and greatly aid them in their future engineering work.

Third.—It will give the students as much practical skill as an apprenticeship of three years in an ordinary shop. In support of this statement, I may say that the results of constant instruction, combined with actual experience on practical work, have surpassed the expectations of the most earnest advocates of this system of training. You would not doubt that the average boy would learn more algebra in a month under a good teacher than in five months by himself. Experience shows that constant instruction is fully as effective and economical of time in learning a trade as in studying a science. This attainment in practical skill opens for every graduate a wide door to the engineering profession. The lowest man in the class can start on wages as a journeyman as soon as be graduates. If called at once to a higher position, his practical course will still furnish much of the knowledge he will be likely to use in the earlier years of his professional work. The effect upon character of a consciousness of independent self-support is worthy of consideration, as a commendation of the shop training.

Fourth.—The addition of the shop department promotes the unity and efficiency of the professional training without detriment to any of its qualities. By making the study of theory and practice simultaneous and concident, their union, which is the necessary condition of educational success, is more readily secured, and its permanence in the subsequent progress of the graduate more certain.

Fifth.—It promotes economy of the student's time by utilizing in variety of occupation the time devoted to the school training; and also by the operation of the principle of combining in study those elements which enter into the desired attainments. A single question remains for consideration. If such a shop and system of instruction as I have outlined has been shown to be desirable and practicable, how can it be started and what outlay of money will be required to found it and carry it on? A shop may be started on this plan by adopting, as the cornerstone of the system, the doing (with the aid of skillful journeymen) of actual marketable work. The plan may be developed to such extent as the means at hand will allow. Experience indicates that as much or more can be accomplished with a given sum of money on this plan as on any other.

If it is adopted, whatever is spent will be so much help toward a more extensive department, because the plan includes whatever it is desirable to accomplish by such a department.

From fifty to one hundred thousand dollars invested in the shop and its equipment would give a good start for the instruction of one hundred students in this department. There would be needed for annual running expenses from eight to twelve thousand dollars. If the products of the shop should pay only for the cost of their production, this sum for running expenses would have to be provided from tuition and endowment. With good business management and fair opportunities, less than half this sum might be required for annual expenses. It should be distinctly borne in mind that the *business* of the shop is no part of the educational work of the department. The plan does not contemplate any union of education and money making. The shop is no more justly subject to this criticism than are academies and colleges because they rent rooms in their buildings and receive money therefrom—a purely business transaction, incidental part of the school, but no part of it. No outlay of money for educational purposes promises to yield so large immediate returns, both to the students and the engineering profession, as that expended in founding and fostering such a department; and while the plan admits of the expenditure of large sums, especially in providing for the higher work which may be done with suitable facilities and instruction, the work may be begun on a small scale and may be efficient as far as it goes.

Whatever is done, be sure that the management and efficiency of the shop meets the approval of practical manufacturers, superintendents, and engineers known to be interested in the thorough instruction of boys in this department.

The training of mechanical engineers is now a subject of such magnitude and importance as to demand patient and candid consideration. Old methods of instruction should be examined and improved, and new methods should be critically sifted before they are adopted. Candor and the well digested results of experience are always helpful.

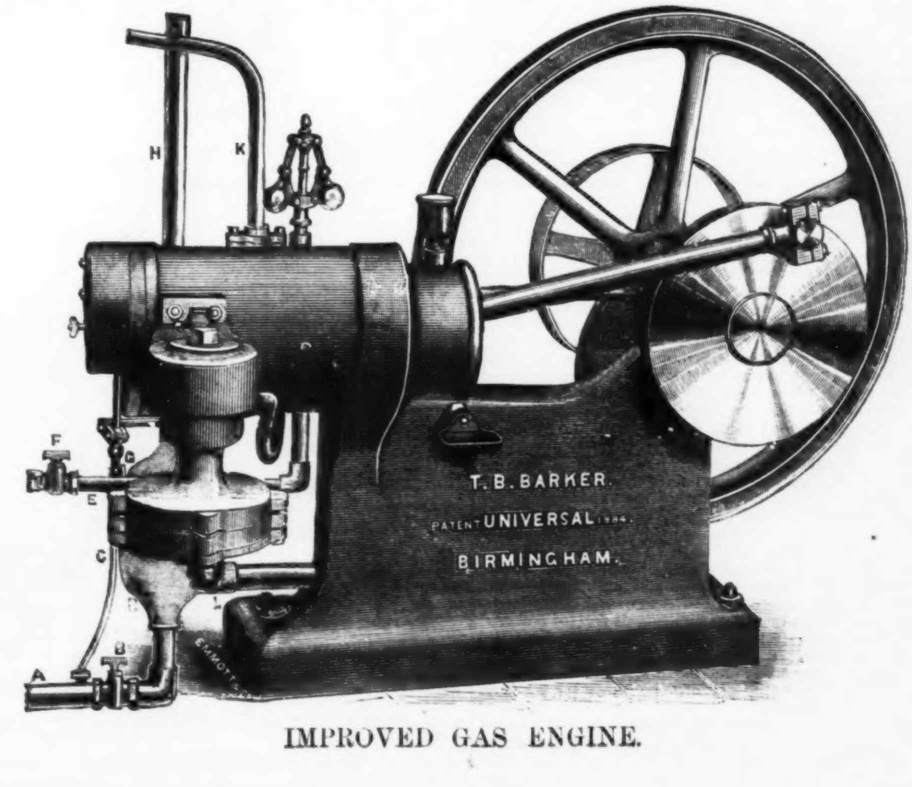
Bringing these to our aid in perfecting a system of training for engineers, we may hope to secure by such training that union of scientific attainments and ability for practical achievements which result in a well educated and developed man and a successful engineer; one who through knowledge is enabled to combine in his constructions that harmony of the laws of matter, force, and energy which the Author of the created universe saw in His own works when He pronounced them all very good.

IMPROVED GAS ENGINE.

IN the West Annex of the International Health Exhibition there is shown a neat form of non-compression gas engine suitable for moderate powers. It is manufactured by Messrs. T. B. Barker & Co., of Scholefield street, Birmingham, and is named by them the "Universal." The method of its action is exceedingly simple. The piston, in moving forward, draws in behind it a mixed charge of gas and air during the early part of the stroke. When the requisite amount has been admitted, a small port in the end of the cylinder is exposed and a blue gas flame sucked through it, with the result that the combustible mixture is exploded and the piston driven forward to the end of its stroke. The exhaust valve is then opened, and the returning piston drives out the products of combustion ready for the reception of a fresh charge. Referring to the illustration below, it will be seen that the engine has a horizontal cylinder with a long piston, to which the connecting-rod is directly pivoted. The gas and air are admitted through lift-valves in the casing at the cylinder end, and are raised by the partial vacuum which is created in the cylinder as the piston moves outward. The amount of gas which is delivered at each stroke is regulated by the governor, and by a cam on the rotating shaft parallel to the cylinder. This cam is so shaped that at one part of its revolution it presses back a spindle and opens a valve. It does not, however, do this directly, but through the intermediary of a movable wedge-shaped distance piece, which stands between the cam and the spindle. This piece is connected to the governor, rising and falling with it, the thick part of the wedge being opposite to the spindle when the engine is running slowly, and the thin part when the speed is greater. When the rate of revolution exceeds a fixed amount, the wedge is raised so far that the gas valve is not opened at all. The main gas pipe is shown at A, and is connected to the flexible bag, D, the upper orifice of which leads to the valve controlled by the governor. The exhaust valve is on the opposite side of the engine from the observer, and communicates with the pipe, H, its opening and closing being effected by a valve on the side shaft.

The ignition valve is at the end of the cylinder, and forms the most novel part of the design. It is a flat disk carried on a central stud, and held against the rear cover by a spiral spring, which can be tightened up by a nut. The periphery of the disk is cut into ratchet teeth, which gear with a pawl worked by a small crank at the end of the side shaft. At each revolution of the engine the pawl suddenly moves the disk to the extent of one tooth, and then leaves it stationary until the crank again comes round. A number of fine radial slits or ports are cut in the disk, corresponding to the number of ratchet teeth, and in the cylinder cover there is also a port which for an instant in each revolution corresponds to and is seen through a port in the moving disk. A blue flame from the jet, G, burns opposite the cylinder port, and when the latter is momentarily exposed, it is drawn into the cylinder and ignites the explosive mixture.

The cylinder is water-jacketed, the fluid entering by the tap, F, and pipe, E, and leaving by the pipe, K. The engine is made in seven sizes of ⅛, ⅙, ¼, ½, ¾, 1, and 2 horse-power, and appears very well adapted for the purposes of small manufacturers, as it is exceedingly simple, and can be readily managed by a person quite unskilled in the management of machinery. The consumption of gas is stated to be from 40 feet to 50 feet per hour.—*Engineering.*



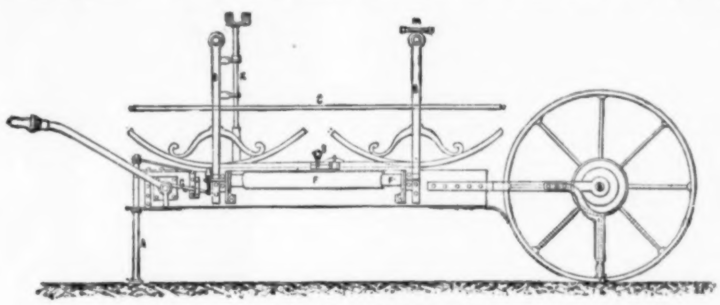
IMPROVED GAS ENGINE.

THE AUTOMATIC TOPOGRAPH.

MR. CHAS. GILLET has invented a surveying and leveling apparatus which he styles an automatic topograph, and which we illustrate herewith. It consists of a wooden frame supported at one end by a small wheel 0·66 m. in diameter, and at the other by an iron rod capable of sliding in its supports. This rod, A, is provided with a small lever at its upper part that serves as a brake to the pendulum, B. It operates as follows: When the rod, A, is resting upon the ground, it bears upon the small lever, which then presses no longer upon the pendulum; but as soon as a person lifts the handles of the apparatus, the rod descends, and the lever, forming a brake, bears upon the pendulum and prevents it from operating. The pendulum, B, then, only operates or becomes plumb when the brake quits it. The other pendulum, B, is connected with the first by two small iron cross pieces, C.

Each pendulum carries at its base a portion of a circumference, to which are attached two brass wires, that are connected with a small pencil holder carriage, D, which slides between two pieces of iron.

As this carriage is thus connected with the pendulums, it advances or recedes when they became vertical, according as the apparatus happens to stop in going up or down hill, and the pencil that it carries at its center marks upon a strip of paper, F, the up or down grade per meter. The band of paper is wound around two cylinders, F', one of which is provided at its extremity with a click and small lever, G, connected with an axle that carries the handles of the apparatus. This axle is movable, and by its motion allows



AUTOMATIC TOPOGRAPH.

one tooth of the ratchet to escape every time a person bears upon the handles. By this means the cylinder revolves a distance equal to one tooth of the ratchet. Each tooth represents 3 meters, and the pencil of the carriage, D, consequently marks the slope or incline upon a length of 3 meters.

Another pencil, placed upon the axle of the machine and supported by a carriage, H, capable of moving in one direction or the other in a guide surmounted by a set screw, permits of obtaining a horizontal line, called a guide line, because, on changing the apparatus end for end, a guide line is obtained as is done in masonry leveling.

This guide line serves for measuring the variation of the pendulums from the horizontal. When the crayon marks lines beneath the horizontal the apparatus is upon an ascending gradient, and when it marks them above, it is on a descending one; upon taking from the scale, then, the height between the guide line and the point of the part traced by the pencil we obtain a figure for the incline per meter, and as the apparatus has a length of 3 meters between its bearing points, the gradient obtained must be multiplied by three.

Near the supports of the pendulums, an iron rod, K, movable in two collars, supports an alidade that serves to set off the angles. To obtain this result the iron rod, K, carries at its lower end a hollowed out part in which is placed a pencil holder and a little guide that allows the pencil holder to move forward 2 cm. to trace the change of direction of the operating line. The pencil holder is provided with a spring, and the operator has only to pull upon this to cause the pencil to move forward. When the spring is set free the pencil moves back, and, in doing so, marks a straight line upon the band of paper, and another at every change of direction.

It takes two persons to manipulate the instrument—one to hold the handles and push the apparatus forward, and the other to place the extremity of a rod upon the ground in order to indicate the exact point where the length of three meters ends. This man must remain in place until the one who is pushing the apparatus along has placed the movable rod, A, at the extremity of the rod which he is holding. He also waits until the pendulums have become vertical before going to the other end of the apparatus. Then, when he sees that the point is marked, he bears upon the handles of the apparatus in order to set one tooth of the ratchet free and unroll the paper. If precautions are well taken, the two men can make ten kilometers per day, by changing places from time to time. As with the water level, it is necessary to perform the operation over again and take a mean of the figures obtained, in order be sure of having made no error. But for operations of little importance once is great plenty, and the result obtained is much more accurate than with a water level.

If an error happened to occur in two consecutive operations, it would afford a proof that the pendulums were not sufficiently movable upon their support, or that the guide line was not exactly at the desired point. This would be very easy to verify by changing the machine end for end upon two fixed points. The scale of up or down gradients is determined by the length that is given to the pendulums. A small spirit level, M, fixed to one of the pendulums permits of ascertaining whether it is exactly plumb.—*Chronique Industrielle.*

ON BOILER EXPLOSIONS.

NOTICING the article published in the SCIENTIFIC AMERICAN SUPPLEMENT No. 456 on "Boiler Explosions," I take the liberty of penning these few lines on the subject.

We must not forget for a moment the first and primary laws of the properties of matter; viz., their correlativeness and indestructibility. Science has taught us that not an impulse of light or heat or power is ever lost, and not a pound of force or particle of motion is ever produced, but at the expense of some other property. Experiment has proved that the expansion of gases reduces their temperature. Compressed air may be used to convert water into ice. And why is all this? Because heat and motion are but one and the same thing differently manifested. A sealed reservoir if at rest cannot create a motion within itself without a corresponding decrease in its temperature. Man has harnessed, so to speak, this property of matter, and has made himself a steam engine; and it is as impossible to draw out a portion of steam without a corresponding decrease in temperature as it is to invent perpetual motion. The heat produced by the combustion of the coal is absorbed by the cold water and *given out again* as motion.

According to the article in question water is combustible, and only a part may be thus exploded at one time, and also this action is instantaneous. When the pressure is reduced a portion of the water explodes, or it yields up a portion of itself, *exactly* as fast, and consequently an *equivalent* decrease in temperature. A steam gauge answers the purpose of a thermometer inserted in the water, and its rise and fall, fast or slow, is indicative of the amount of energy or heat which is at the time stored in the water, and it does not show the amount in bulk of steam that may be drawn off at one time. This steam is in reality drawn from the water and not the boiler.

A steam boiler may be compared to a lever and its fulcrum, with heat sitting on the one end and motion on the other. As one moves the other moves, and in a never varying ratio. And as a lever may be moved quickly enough to do damage, so may the heated water in a steam boiler be converted into steam fast enough to be a serious condition; but this is hardly possible with the arrangement of most boilers, or through an orifice of any usual or reasonable size.

A sudden jar may also be a serious thing; but when we consider that most stationary boilers have steam pipes fitted with globe valves, which open and shut with a screw, ought we not to look for some other cause for explosions?—especially when right in our faces and eyes are thousands of locomotives and small portable boilers which are provided with what are commonly called "pop valves." Nothing could open or shut quicker than one of these, and the opening is usually very large; yet during the experience of the writer he never saw a steam gauge move as if a jar had been produced in the boiler. The pressure usually falls about five pounds, and that is all there is of it.

What then, you may ask, causes boiler explosions? When, from whatever cause, the pressure in a steam boiler becomes greater than it can bear, it will surely go, and undoubtedly the rapid combustion of the water lends its fearful power.

The low water theory is in accordance with the laws and properties of matter; it superheats the steam, and admits into the boiler a dangerous amount of latent energy, which, should it by any possibility get into the water, might cause its too rapid combustion.

One thing is sure, when a boiler bursts, either it was not strong enough to bear the pressure, or else it had stored within itself a latent energy.

Until the good times come, when boilers cease to get rickety, when engineers cease to get drunk, and when blockheads cease to live, or better yet, when we discard this for a better process of generating power—till then, let us repeat, we must ever be on our guard, and expect to hear once in a while from a fearful boiler explosion. E. E. D.

CLAUDE JOUFFROY.

THE accompanying engravings represent a statue to the memory of Claude Jouffroy, which was unveiled at Besancon

THE STATUE OF JOUFFROY.

on the 17th of August. It is due to the chisel of Mr. Charles Gautier, who has often presented the public with specimens of his talent. Its execution was secured through public subscription, at the instance of the Academy of Sciences, which appointed Mr. Ferdinand De Lesseps to represent it at the inaugural ceremonies.

We shall recall on the present occasion the principal episodes in the life of the Marquis De Jouffroy, which form a splendid page in the history of modern discoveries.

Claude Francois Dorothee, Marquis De Jouffroy, who was born about the year 1751, was a scion of a great family of Franche-Comte. At the age of twenty he entered the regiment of Bourbon Infantry; and it was at Paris, in 1775, that he conceived the idea of applying steam to navigation, as a consequence of a visit to the steam engine of Chaillot, an establishment that had just been started by the Perier Brothers.

THE STATUE OF JOUFFROY.

Claude Jouffroy developed his idea before Perier, Chevalier De Follenay, Marquis Ducrest, and D'Auxiron. It was received and discussed, but no agreement could be arrived at as regards the calculation of the power to be overcome. While Perier was immersed in fruitless experiment, Jouffroy, aided by a mere village coppersmith, succeeded in running a boat by steam upon the Doubs, at Beaume-les-Dames, in the months of June and July, 1776. His apparatus consisted of rods, 8·75 feet in length, suspended from each side of the boat toward the bow, and carrying at their extremities frames provided with movable paddles that dipped into the water to a depth of ten inches. The frames, which described an arc of 8·75 feet radius, were held at the end of their travel, toward the front, by a lever provided with a counterpoise. The motor was a single-acting engine, whose piston communicated with the rods through a chain and guide pulley.

The first trial was not a complete success. At the same epoch Jouffroy wished to enter the artillery or the engineer corps, but his relatives remonstrated, as they regarded it as degrading. His mechanical researches were made fun of; he was dubbed Jouffroy the Pump; and at Court he was joked about, the saying being that "he wished to reconcile fire and water." He persevered in his project, however, and first sought a means for obtaining a continuous motion.

Not being able to succeed in remedying the defects of his first floating apparatus, he decided, though with regret, to substitute paddle wheels for the rods and frames. The barrel with its click and pawl arrangement, around which wound the chain connected with the piston, he placed upon the wheel shaft. This latter was alternately revolved by one of the chains. This apparatus he put into a boat 142 feet in length by 15 in breadth. The wheels were 15 feet in diameter, and their paddles, which were 6·5 feet in length, dipped into the water to a depth of about two feet. The boat's draught was a little over three feet. It was built at the works of the Brothers Jean, at Lyons, whence it sailed as far as Barbe Island, on the 15th of July, 1783, in the presence of the members of the Lyons Academy and numerous witnesses.

After this, Jouffroy endeavored to form a company for building larger boats to run on rivers; but for this he had to obtain a grant, and he asked the government for one for thirty years. The request was sent to the Academy of Sciences by De Calonne. This learned body, to which Jouffroy at the same time addressed a memoir upon steam engines, appointed Borda, Bossut, Cousin, and Perier to examine the memoir, and Borda and Perier to examine the boat. Perier, who had failed on his part in his trials to navigate by steam, did not wish to believe in the practical success of the experiment indicated. He led the Academy to pass no judgment upon it, and the minister wrote Jouffroy, Jan. 31, 1784, as follows:

"It appears that the experiment made at Lyons did not sufficiently fulfill the required conditions. But if, by means of the steam engine, you succeed in causing a boat loaded with three hundred thousand weights to ascend the Seine a few leagues, and the success of this test be established authentically at Paris, so as to leave no doubt as to the advantage of your process, you may rely upon it that you will be accorded a patent limited to fifteen years."

Jouffroy did not try to fight against this final non-acceptance. His engine and trial boat had been put out of service by the first experiment. He contented himself with getting up a small model of his boat, which he sent to Perier the same year. He was advised to carry his invention to England, but he could not decide to do so. Finally, the Revolution came, and he was one of the first to emigrate. He served in the army of Conde, and took part in a few attempts in favor of the Bourbons. He did not return to France until the time of the Consulate. Desblancs and Fulton were then occupied with steam navigation, the former at Trevoux, and the latter at Paris. A quarrel arose between them, and Fulton declared that if it was a question of an invention, *that* glory belonged to the author of the experiments at Lyons—"of the experiments made in 1783 upon the Seine." Fulton's boat was, in fact, the same as Jouffroy's, the engine alone being different. Watt had invented the compound engine, and that rendered the application of steam to navigation easier.

Upon his return, Jouffroy found himself fortuneless. At the Restoration he settled in Paris, obtained a patent in 1816, formed a company to work it, and finally found money and protectors. Count D'Artois even permitted him to give the name Charles-Philippe to his first steamboat, built at Bercy, and launched Aug. 20. But a rival company ran opposition to him, and both were ruined. Jouffroy, thoroughly undeceived, fell into oblivion. After the revolution of July he retired to the Invalides, where he died of cholera.—*La Nature.*

DR. JOSEPH JANVIER WOODWARD.

COLONEL J. J. WOODWARD, Surgeon United States Army, died near Philadelphia, August 18, 1884. Surgeon Woodward was one of the physicians in attendance on the late President Garfield, and had been in bad health for a long time. He was born in Philadelphia in 1833. He was educated at the Philadelphia Central High School, from which he received the degree of A.B. in 1850, and that of A.M. in 1855. He studied medicine in the medical department of the University of Pennsylvania, and, after graduating, practiced medicine in Philadelphia. He was a good surgeon, and, in addition to his practice, gave lessons in microscopical and pathological anatomy.

"Entering the army in June, 1861, he saw much active service, and rose rapidly. He was present at the siege of Yorktown, and the battle of Williamsburg, Va. He was brevetted captain, major, and lieutenant-colonel in the United States Army for faithful and meritorious services, and was assigned to the Surgeon-General's Bureau at Washington. He was appointed chief-assistant soon after. He was the medical editor of the "Medical and Surgical History of the Rebellion." His professional labors were of distinguished character, none more so than his comprehensive series of experiments in microscopic photography, by which the profession has been placed in possession of records of the highest value and usefulness. Among his published papers are "Address on the Medical Staff of the United States Army," "Remarks on Croup and Diphtheria," "Typho-Malarial Fever—Is it a Special Type of Fever?" *Transactions* of the International Medical Congress of 1876; "Remarks on Photographic Micrometry," *Transactions* of the American Medical Association of 1876; "Application of

the Photograph to Micrometry," with special reference to the micrometry of blood in criminal cases, *ibid.*; report on "Medical Literature," *ibid.*, 1870; report on "Causes and Pathology of Pyæmia," (Septæmia,) *ibid*, in 1866. He was a member, during his residence in Philadelphia, of the Philadelphia County Medical Society; was a member of the American Medical Association, and was second vice-president in 1875; was a delegate to the International Medical Congress at Philadelphia in 1876, and of the Medical Association of the District of Columbia. He was married; and at the meeting of the American Medical Association, at Richmond, in May, 1881, was elected its president."

J. L. PULVERMACHER.

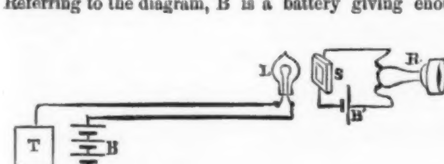
THIS well known inventor, whose name will always remain connected with portable voltaic appliances and atmospheric depolarization, passed away, after a long illness, on September 12. The work done by Mr. Pulvermacher has received in this country very little recognition among professional and scientific men, mainly by reason of the extensive system of advertising by means of which the inventor found it necessary to bring his appliances before the public. In justice to him, therefore, it should be pointed out that the portable batteries of Mr. Pulvermacher, however unscientifically they may frequently be applied in the absence of medical supervision, are essentially of a genuine and scientific character, and that they were devised by a man who had made the voltaic battery the study of his life. In this respect they are in strong contrast to the multitude of quasi-voltaic and "magnetic" appliances with which the advertising columns of the daily and weekly press have recently been inundated. It was mainly with a view to obviate the effect of this threatened prominence of sham voltaic curatives, through which the public are swindled on an extensive scale, that such men as Professors Petrina, Kreil, Ettinghausen, and Oppolzer, in Germany, and Golding Bird, Pereira, Ronald Martin, Locock, Holland, and Fergusson, in England, gave their unqualified testimony to the genuine nature and to the "great importance to scientific medicine" of Pulvermacher's voltaic batteries and galvanic appliances.

To Pulvermacher, originally a working jeweler, attending with enthusiastic interest the lectures on natural philosophy of Professor Hessler, at the University at Prague, belongs the merit of first having recognized the fact that in order to transmit a current through a high resistance, more especially when such resistance is that of an electrolyte exhibiting the effect of polarization of electrodes, a considerable number of very small cells in series is far more efficacious than a single couple of large elements, or even than several such elements, necessarily of an inconvenient and unportable character. To him also is due the credit of recognizing the importance of atmospheric depolarization in the case of single fluid batteries; and his paper "Sur une pile a un seul liquide se depolarisant par l'action de l'air atmospherique," read before the Academie des Sciences, by M. Du Moncel, in July, 1878, may still be perused with advantage by electrical students. The work done by Pulvermacher, as early as 1846, in relation to magneto-electric machines, may very possibly be some day disinterred and found to present considerations of importance. But, as we have said, he will be remembered by reason of his work in relation to portable single-fluid voltaic batteries. As a contemporary has well observed, it may to the uninitated appear a small matter to have invented and perfected a voltaic battery requiring no vessels to contain the "exciting fluid," and no depolarizing oxidant save atmospheric air, charged in a few seconds, flexible and portable; but this, with the machinery for its production on a large scale, represents in truth the labor of a lifetime. In this case, it is one that has been better appreciated, from a scientific point of view, in France than in this country.—*The Electrician.*

SPEECH FROM LIGHT.—THE CORRELATION OF PHYSICAL FORCES.

BY the aid of a current of electricity heat is produced to the extent of giving light, which, in its turn, shall be so utilized as to produce speech, and this I propose to accomplish in the following manner:

Referring to the diagram, B is a battery giving enough



current to bring the small filament lamp to a state of incandescence. T is a telephonic transmitter, placed in circuit with the battery and lamp. On a separate and independent circuit are placed the selenium cell, S, a battery cell, B', and the telephonic receiver, R.

So long as the circuits are left in their normal conditions—the selenium cell being placed under the influence of the light from the lamp—a constant current will be the result in both cases; but so soon as the operator begins speaking to the transmitter, T, the current strength will vary, and the luminosity of the lamp, L, will be subject to continual change.

This variation in the light will in turn alter the resistance of the selenium cell, and the current flowing through the receiver, R, will vary in like manner. Thus it appears possible to transmit speech through the media of an incandescence electric lamp and a selenium cell; the telephonic transmitter being placed in circuit with the one, and the receiver being connected with the other, both circuits, however, being absolutely separated.—*Electrical Review.*

THERMAL COLORED RINGS.

M. DECHARME, whose experiments on the flow of currents in pipes and their hydrodynamic analogy to electric currents have attracted much attention, has also recently drawn attention to the fact that thermal colored rings bear a striking resemblance to electro-chemical colored rings. When a copper plate is exposed to the flame of a spirit lamp or a Bunsen burner, an irisated or rainbow colored corona is produced about the heated point. Under good conditions these colors are fixed and unalterable in the air. These rings are, according to M. Decharme, quite similar to Nobili's electro-chemical rings; like the latter they succeed each other in waves, the colors being in the same order, namely, that of Newton's rings viewed by transmission.

NEW METHOD OF MANUFACTURING SELENIUM PILE ELEMENTS.

MESSRS. C. E. FRITTS and D. H. HOPKINSON have devised a new process for manufacturing very sensitive selenium elements in which the entire mass is influenced by light. This result is obtained by a preparation of the selenium itself, and the construction of elements whose sides are made of a material that conducts both electricity and light well. Several thin sheets of reheated selenium are inclosed between these sides, and it results therefrom that the current traverses the selenium in the direction of the light that strikes it; and it appears that, owing to this arrangement, the changes in resistance caused by the light (or, in other words, the property that selenium possesses of regulating light) become much developed.

The selenium is selected in as pure a state as possible, and

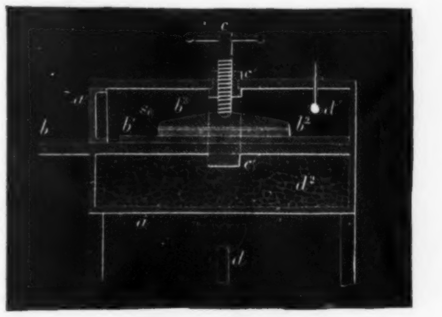


FIG. 1.

is formed into sheets that are placed between blocks of a material to which it does not adhere. The selenium is softened by heat, so as to render it as thin as is judged necessary, and the sheets are afterward cooled under pressure. Two thin sheets of mica are introduced between the selenium and the blocks, so as to facilitate the separation of the sheets of selenium and the blocks forming the mould. When it is desired to have sheets very sensitive to the light, it is necessary to make them so thin that they appear, before reheating, of a blood-red color when they are looked at against the light.

Fig. 1 shows the press employed for softening the selenium plates by this process. It consists of a heating box, *a*, with a door, *a'*, and a strong shelf, *b*, provided with a groove in which slides the piece, *b'*. A screw, *c*, serves to exert pressure, and *c'* represents a support which passes along the

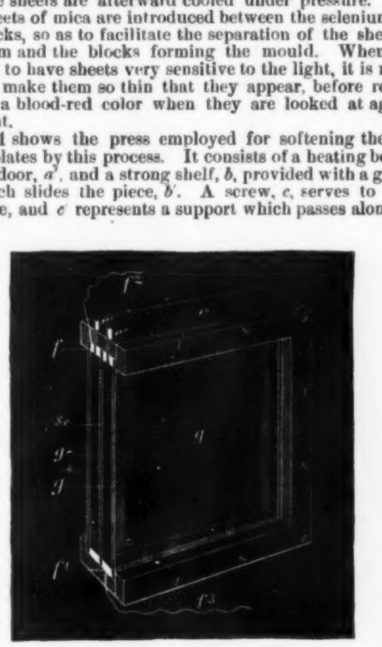


FIG. 2.

sides of the box and over the shelf, *b*. A gas flame, *d*, furnishes the heat, and a thermometer, *d'*, shows the temperature. The apparatus is completed by a certain quantity of scrap iron, which equalizes the temperature under the pressure plates, b_2 and b_3. These latter are placed upon a movable piece, *b'*, and their position is so regulated as to make their center coincide with the axis of the screw, *c*, which then exerts an equal pressure. By this process the selenium is softened and converted into sheets of the desired thickness. In order to make elements of these sheets, one of them is fixed (Fig. 2) in the center of a rubber frame, *e*, provided on each side with metallic supports, *f f'*, and the sheet is insulated from the latter by bands of a proper material. On each side there is a glass cover, *g g'*, fixed to the rubber frame, *e*, by cement. The supports, *f f*, are connected with the wires, f_2 and f_3, and communicate thereby

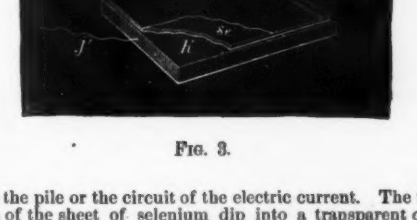


FIG. 3.

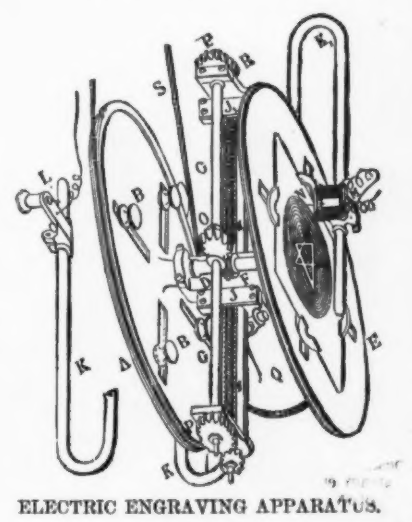
with the pile or the circuit of the electric current. The two sides of the sheet of selenium dip into a transparent conducting liquid, which is poured into the elements by means of tubes, *e e'*, that likewise serve for the exit of the gases formed through the electrolysis of the liquid. The light traverses the liquid and falls upon the selenium plate of the element, and the current reaches the plate by the same route. Sometimes wires placed at equal distances are made to pass through the liquid, in order to secure an equal distribution of the current in the liquid electrode. These wires are stretched between the metallic supports, *f* and *f'*. Moreover, movable shutters are sometimes placed upon the glass sides of the element, so that the light that strikes them may be regulated.

Instead of a liquid conductor, sheet platinum, gold, or silver is sometimes used as the electrode of the selenium, but this must be thin enough to allow the light to pass through it. Goldleaf answers very well, and, when used, is first wet with alcohol, and the selenium is then placed over it, and afterward reversed so that the gold shall be on top. The goldleaf is then spread smoothly by blowing over its surface. After the gold has been connected with the circuit, it is covered with glass or a transparent varnish, in order to fix it in place and protect it against accident.

Fig. 3 represents a dry element of this kind that has given very good results. *s e* represents the selenium between a metallic plate, *h'*, and a piece of goldleaf, *i'*, to which a wire, *j*, of the circuit is attached. The current in this case passes from the entire surface of the goldleaf to the lower plate, and traverses all parts of the sheet of selenium. This latter is entirely exposed to the action of the light that traverses the goldleaf.—*La Lumiere Electrique.*

ELECTRIC APPARATUS FOR REPRODUCING DRAWINGS.

MR. A. SCHMID'S apparatus for engraving and the reproduction of drawings consists of a frame, Q, which supports a shaft, D, provided at its center with an endless screw, F, and at its two extremities with two disks, A and E, which are keyed to the said shaft. Perpendicularly to this latter there is arranged a second shaft, G, which carries a helicoidal wheel, O, that gears with the screw, F, and, at each of its extremities, a toothed wheel, P. These wheels gear, each of them, with a pinion, R, mounted at the extremity of a threaded rod, HH_1. If, by means of a belt, S, the disk, A, be made to revolve, the motion will be transmitted, through the intermedium of the gearings, F, O, P, R, to the rods, A and H_1, and the pieces, J and J_1, which form a nut and are guided in a frame, will be moved parallel with the axis of the said rods. Each of these disks, A and E, is provided with four screws, B, which are capable of moving in apertures running in the direction of the radii, and which permit a plate of variable size being affixed to the disks. The piece, J, is connected with a rod, K, which is bent into the form of a stirrup, and carries a metallic point, L, at its extremity. This point is fixed to any part whatever of the rod, K. A rod, K_1, analogous to the last named, is connected with the piece, J_1, and the latter supports a small electro-magnet, M, whose armature is provided with an engraving or tracing tool, N. If the two points, L and N, be brought to the center of the disks, A and E, and the device be afterward set in motion, it is evident that each of the tools will describe a spiral upon



ELECTRIC ENGRAVING APPARATUS.

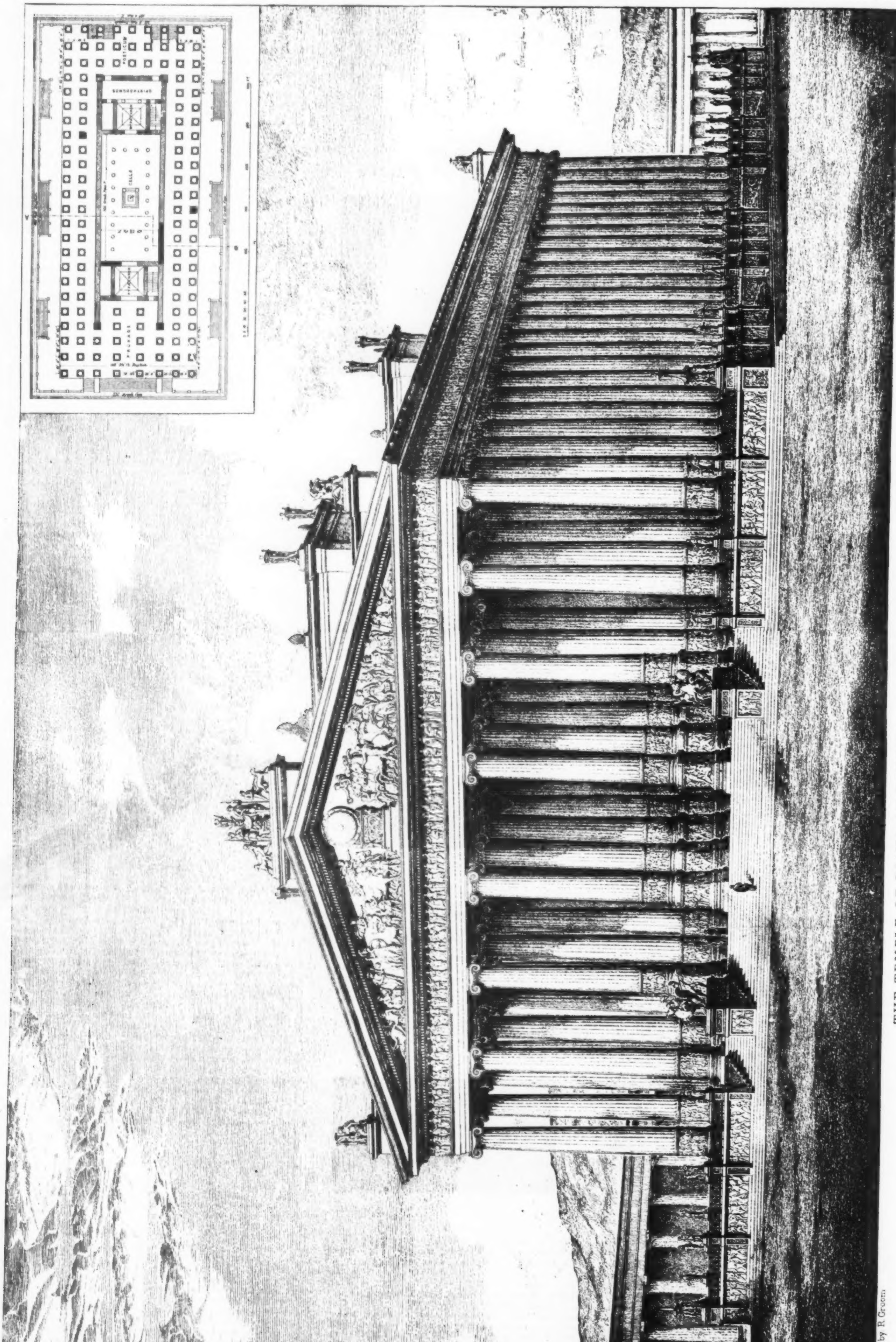
the corresponding disk, and if the movement of the p[illegible] J and J_1, is slow enough, the engraving tools will succ[illegible]sively occupy all the points of the plane over which they a[illegible] passing.

This granted, it is very easy to see how the apparatus works. The plate upon which it is proposed to engrave or simply reproduce a drawing is fixed to the disk, E, and the original plate to the disk, A. The original may be made in two ways: a drawing may be executed upon a metallic plate by means of a non-conducting color, or upon paper with a color having a metallic conducting base. The two points, L and N, are brought to the center of the disks, A and E, and the apparatus is then set in motion. The piles (which vary in number according to the effects that are to be obtained) and the electric connections are so arranged that the current is closed, or, in other words, the electro-magnet attracts its armature every time the tool, L, passes to a contact with a conducting part of the plate over which it is moving. The style, N, in both cases traces a spiral.

It is useless to add that by varying the velocity of the threaded rod, H, with respect to that of H_1 (which may be easily done by changing the toothed wheels, P and R), an original drawing may be reproduced upon any scale.—*Dingler's Pol. Journ; La Lumiere Electrique.*

THE ELECTRIC RAILWAY, BRIGHTON, ENG.

THE extension of the Brighton electric railway line having now been in active operation for six months, a few particulars may be interesting, as showing the capabilities of a light line of this description. The car mileage amounted to 15,600 miles, or 100 miles per diem; the number of passengers in round numbers, 200,000; this figure would be increased but for the fact that at certain times the would-be passengers exceeded the capabilities of the car, which seats thirty persons only. The consumption of gas in the gas engine has been 300,000 cubic feet, or 13 cubic feet per passenger per mile. The total cost of traction, including interest and depreciation on engine, dynamo, and motor, cost of gas, oil, and attendance, has amounted during that period to 15s. 6d. per day—100 miles run—say 2d. per mile. The car service has only been stopped for one day, through the tires of the wheels giving out, owing to the heavy pressure of the holiday traffic, there being at the time no second car available.



THE TEMPLE OF DIANA AT EPHESUS, RESTORED BY JAMES FERGUSSON, F. R. S.

Drawn by R Green

THE TEMPLE OF DIANA AT EPHESUS.

THE restoration of the temple of Diana at Ephesus, of which we present our readers with an illustration on the opposite page, is based wholly on the discoveries made by Mr. J. T. Wood during the excavations on the site between the years 1863–1874. The temple was apparently first thrown down by an earthquake in early Christian times, and since that period has served as a quarry and limekiln for successive cities on the spot, till very little indeed remained of it when Mr. Wood discovered its site and the remains buried under an accumulation of 20 feet of mud and sand washed down from the neighboring hills. Though the remains were, consequently, scant, they were fortunately such, when combined with the accounts of it left by the ancients, as enabled the plan and form of the temple to be made out with very tolerable certainty.

The peristyle of the temple consisted of the unusual number of 127 Ionic columns, each 60 feet in height, disposed so as to form an exceptionally widely spaced octastyle in front, the extreme awkwardness of which was remedied by the introduction of nine columns in the rear and 24 on the flanks, counting the angle ones twice. Thirty-six of these columns, we are told by Pliny, were "celatæ," which, from the examples brought home by Mr. Wood, we now understand to mean adorned with a range of sculptured figures, about life-size, incircling them above the base; but, from the fragments brought home and now in the British Museum, we learn that a certain number of these—probably half the number—were mounted on square pedestals, as shown in the restoration, which must have added very considerably to their richness and artistic effect. Besides these sources of magnificence, Mr. Wood discovered that the temple was placed on a podium or styobate raised about 10 feet above the pavement of the surrounding courtyard, forming what Pliny calls the "universum templum," 425 feet in length by 220 feet in breadth. If this was adorned with sculptures, as we know that the podium of the altar at Pergamus was, it must have added very considerably to the grandeur of the temple; and, if adorned with groups of sculpture and candelabra, and other ornaments suggested in the drawing, must have rendered the temple not only the largest (which it certainly was), but the richest, existing in ancient times, and worthy to be ranked as one of the seven wonders of the world.—*The Building News.*

MODIFIED ELECTROLYTIC EXAMINATION OF ARSENICAL COPPER ORES AND SLAGS.

THE copper ores extracted at Falun generally contain arsenic, the presence of which interferes with the electrolytic deposition of copper. The precipitate of copper from a solution of sulphuric acid being intermixed with metallic arsenic yields a percentage which exceeds the real amount of copper contained in the sample. In view of this defect of the present methods, A. Ackerblom has devised a modification of the electrolytic estimation of copper which admits of an accurate determination within a comparatively short time.

The sample used for examination weighs from 1 to 5 grammes, according to the quality of ore, is pulverized, and placed in a deep porcelain dish with spout. A small quantity, 0·3 to 0·5 gramme of potassium chlorate is mixed with the sample, the basin covered with a glass plate, and 10 c. c. of fuming nitric acid introduced at once. On suddenly adding the whole measure of acid the decomposition of the powdered mixture is effected without loss of substance, while introduction of a small portion at a time causes spattering of the sample. It then is heated to ebullition for two hours, left to itself, and when cold diluted with water; 5 or 6 c. c. of sulphuric acid of 1·83 specific gravity are run into the solution, and the vessel heated for two hours on a sand bath. Treatment of the ore with potassium chlorate purports the oxidation of sulphur and thus accelerates decomposition of the ore; deposition of sulphur in state of finely divided powder causes formation of globules on boiling of the mixture, which envelop a portion of the ore and protract the process of dissolution. The sample being free of sulphur or containing but traces of it, like the residue obtained by extraction of copper in the humid way, is dissolved in 15 c. c. aqua regia, and then treated with 8 c. c. sulphuric acid of 1·83 specific gravity. After heating the basin for one or two hours on the sand bath, all nitric acid and chlorine is expelled, it is allowed to cool, and the liquid diluted by addition of 60 c. c. water; the dish being replaced on the sand bath, is heated with stirring at intervals until copper and iron sulphate are redissolved. It is filtered into a flask of 400 c c. capacity, filter and residue exhausted with hot water, and a solution of sodium hyposulphite poured into the boiling filtrate. Introduction of the precipitant is discontinued as soon as the liquid has been rendered colorless. Prior to the precipitation of cuprous sulphide, all the ferric sulphate is transformed into ferro sulphate, and the solution now yields, on boiling for some minutes, a black sediment of cuprous sulphide. Complete removal of copper from the solvent is indicated by deposition of finely divided sulphur by adding one or two drops of the reagent to the supernatant liquid. Excess of sodium hyposulphite accelerates filtration and precludes the precipitate from passing through the filter; the precipitate is freed from the adhering saline liquid by washing with hot water, during which operation cuprous sulphide suffers not the slightest decomposition; it is transferred to the air bath, and dried at 110° C. The dried filter and precipitate, being carefully detached from the funnel, are placed in a porcelain crucible, the filter ignited, and the crucible heated to ignition over a Bunsen's burner to complete calcination of the organic fiber. On transferring the residue to a beaker of 200 c. c. capacity—traces of cuprous sulphide adhering to the crucible being detached by means of a soft brush or dissolved in a few drops of nitric acid—a measure of 6 c. c. pure nitric acid, free of chlorine, is added, and the vessel heated for a few minutes on the sand bath; when the quantity of cuprous sulphide is quite large, fuming nitric acid is preferably employed as solvent. When the globules of sulphur produced during heating of cuprous sulphide in nitric acid appear black, further addition of acid is necessary, and the boiling continued until they have assumed a yellow color. The solution of copper nitrate is diluted with water, and then used in the electrolytic determination of the metal. A weighed platinum cylinder as negative and a platinum spiral as positive electrode are inserted into the beaker, both are fixed in a suitable support, and the solution submitted to electrolytic action for twelve hours. The deposition of metallic copper adheres well to the platinum cylinder, and yields a coherent film of rose-red color; the cylinder is finally plunged into water, then washed in alcohol, and dried at 80° C. Lead generally associated with copper is deposited as peroxide upon the positive electrode. The presence of this metal impairs the result obtained in the gravimetric determination, being transformed into sulphide when heated with cuprous sulphide and sulphur in a current of hydrogen. The electrolytic method admits the examination of several samples within a relatively short time, and can be employed in the determination of copper in iron.

MOUNTING AND COLORING PHOTOGRAPHS IN IMITATION OF OIL PAINTINGS.

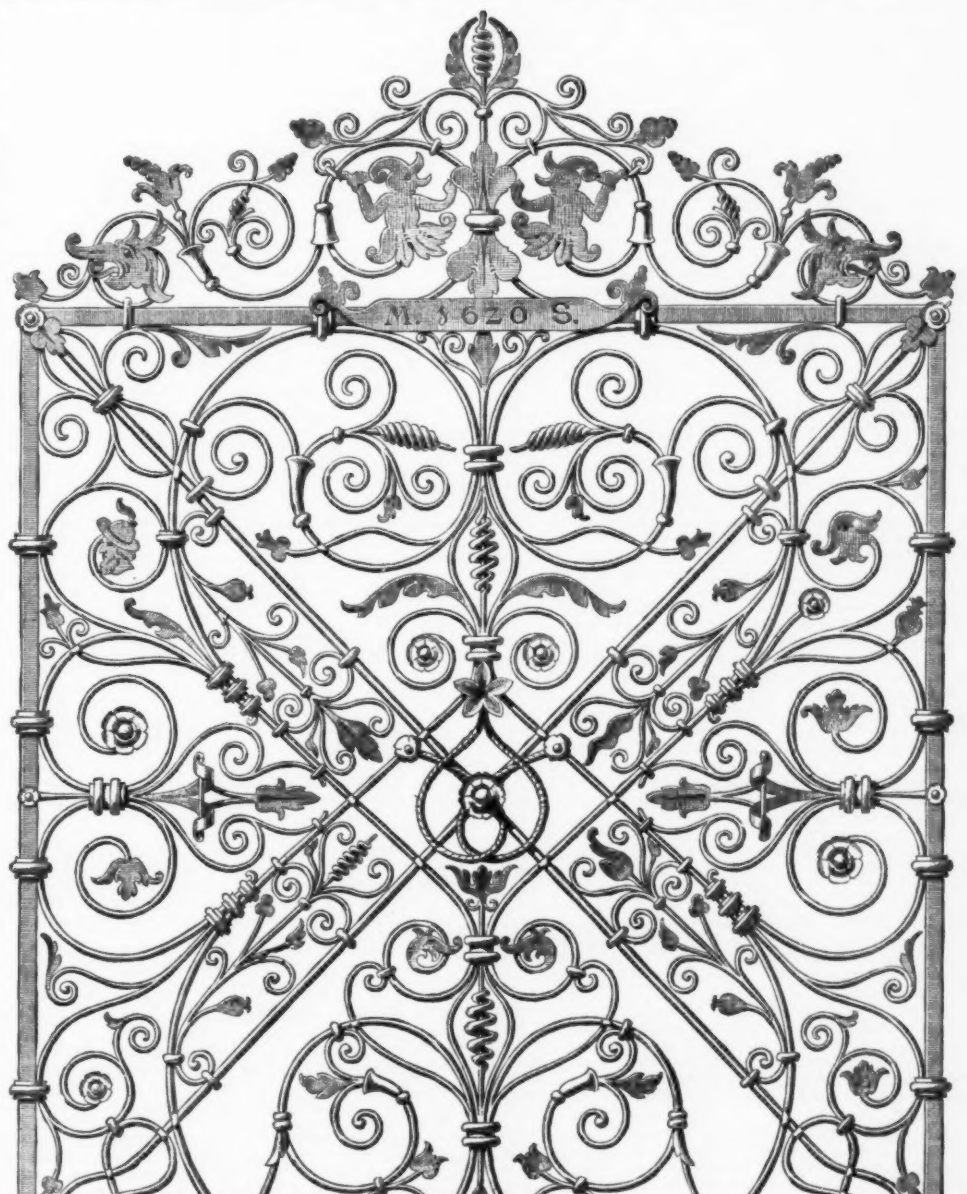
THE hundred-and-one methods of endeavoring to obtain artistic results in coloring photographs without the possession of artistic skill seem, says the *Photo. News*, to depend in the main on similar principles; and putting aside the general fact that a colored photograph is almost of necessity very imperfect, fairly satisfactory results may be obtained, by the method termed "canvasine," of which the following description is extracted from a recent number of *Household Words*. The prints should be made from fully exposed (and not over-dense) negatives, and on thin paper not too highly albumenized. As it appears that the main object of the article, which we quote, is to call attention to secret preparations such as *canvasine solution, adhesive medium*, and *canvasine medium*, it may be mentioned that for mounting the paper print, which has been reduced in thickness by glass-paper, a hot ten per cent. solution of gelatine answers admirably, the print being soaked in the gelatine solution. Before proceeding to lay a second sheet of canvas on the face, or to color, it is necessary to clear away all gelatine from the face of the print by means of a sponge charged with warm water. Ox gall may be used instead of the preparation termed canvasine medium, and ordinary water colors are suitable.

Any one familiar with photographic work will diverge somewhat from the subjoined directions, which we, as before stated, quote from *Household Words:*

"To those who are fond of coloring and painting, and yet who are not gifted with a talent for drawing or designing, or with any large amount of knowledge of the art of producing a pleasing picture, canvasine will be an agreeable amusement. This work does not claim any high place among the pursuits that require a lifetime of labor to bring to perfection; it is simply known as a process whereby an ordinary photograph, taken upon paper, can be colored and mounted so as to resemble an oil painting. The way to transform a mere black-and-white design into a colored picture is very simple, and requires no knowledge of drawing or even of painting; the photograph supplies the outlines, and the impression is not obliterated by the introduction of color, as paints are so prepared that they amalgamate with the chemicals used in producing the photograph, and sink into, and become incorporated with, the paper. By this arrangement, the shadows, half-tints, and lights of the black-and-white original design are still prominent, and appear like natural shadows in the coloring.

"The system employed in thus painting and allowing the color to sink into the photograph consists of laying on coats of color, and wiping them off before more than a tint has become absorbed, the colors being so strong, that, if allowed to sink at once into the paper, a crude, hard coloring would be produced. The only art the student has to acquire is the art of patiently laying on successive washes of color, and wiping them away, until the tint that has sunk in, and been retained by the photograph, is a soft, natural coloring, resembling in its smoothness ivory-painting. In order to transform the photograph into an oil-painting, it is stretched on picture-canvas and rolled with a ruler, so that the coarse thread lines of the canvas show through the photograph in the same way that canvas appears through an oil-painting, and, after the amalgamated tints have been obtained, rough strokes of opaque color are worked on, and allowed to remain on the surface to imitate the rough lines of all coloring.

"The manner of painting is as follows: Choose a clear photograph of one figure only, or of some very distinct group, and match it as to size with the canvas and wooden frame; cut the photograph a little smaller than the wooden frame. Lay the photograph, face downward, on a drawing board, and rub it with fine glass-paper, just to take away a little of the thickness, but not so as to remove it unevenly. Drop the photograph into a soup-plate, into which pour canvasine solution, so as to cover the picture; let it soak five minutes in the solution, then pour the solution back into the bottle; lay the photograph face downward on the table, and dab off any of the solution remaining on the surface. Well wet the canvas to be used (which must be larger than the photograph, with a margin of an inch and a half all round), and stretch it on a drawing-board, holding it down with drawing-pins. Cover the back of the photograph with a good coating of adhesive medium, and lay it on the canvas, so that it is placed in the center of the latter, and the lines and threads of the canvas run straight with the lines of the photograph. Over the photograph place a piece of spare and dry canvas, arranging its lines in the same direction as those on the wet canvas. Take the roller and firmly roll it backward and forward over the canvases and the picture, until all the creases and air-bubbles on the latter are pressed out; it firmly adheres to the first canvas, and the thread lines are brought out upon it. The spare piece of canvas should be lifted from time to time to see the progress made, and extra pressure applied to any parts of the picture that require it. Extra adhesive can be used, so that the edges of the photograph stick firmly to the canvas. Leave



SUGGESTIONS IN DECORATIVE ART.—IRON TRELLIS WORK AT ZELL, NEAR WAIDHOFEN, AUSTRIA.

the picture stretched on the board for three hours or more, and until it has perfectly dried; then commence the coloring.

"Before painting, lay over the picture, with a sponge, a little canvasine medium, then put a little of the medium into a tumbler of water, and use that to mix the colors with. Prepare a wash of flesh No. 1, fill a brush with it, and pass it quickly over the complexion, then with a clean sponge wipe the wash off. Some of the color will have sunk into the photograph, and will look rather spotty; repeat the washes and the wiping them away, until all the greasiness of the surface has been overcome and a pure color obtained. Apply flesh No. 2 in the same way to warm the cheeks, and flesh shadows to the sides of the face, putting these over the first washes. Tint round the eyes and nose, the temples, under the chin, and other parts of the face, and when all these places are colored, amalgamate the whole together with washes of flesh No. 1 laid over the whole complexion. Mark out the features, the lips, the eyes, and eyebrows, with more decided colors, and do not wash these last touches off unless they have been laid on too strongly. The draperies, backgrounds, and other details are all obtained and colored in the same way—full, clear washes of the desired tint laid on and taken off, and final touches put on with pure color.

"The picture painted and dry, it requires fixing to the wooden stretcher. Neatly fit it to the frame, and take hold of the margin of clean canvas, and nail this to the back of the frame, so that the canvas is quite stretched out and smooth. When this is accomplished, take the eight small wedges given with each frame, and hammer these firmly into their proper apertures. All canvasine pictures are much improved by being framed in deeply sunk and wide gold frames, as by the use of these frames the picture does not come close to the surface, and the simulated effect of an oil-painting is much enhanced."

THE CHEMISTRY AND VALUATION OF COAL.

By Alfred K. Glover.

The economic value of practical chemistry cannot be more fully exemplified than in the analysis of coals destined for purchase by our large manufacturing establishments.

The varieties of coal in the market are so numerous, and their chemical and physical characteristics so widely different from each other, that, in order to obtain an impartial estimate of their comparative value as a source of heat, a chemical analysis and valuation is absolutely necessary.

The use of anthracite or "hard coal" is widely extended, for, though possessing theoretically less heating power than bituminous coal, it is often advantageously employed on account of the small amount of volatile material present; in virtue of which but little heat is lost during combustion.

But when smoke burning furnaces are employed, soft or bituminous coal is both theoretically and practically the best possible fuel on account of its higher calorific power.

Coal in general may be regarded as constituted of fixed and volatile carbon, hydrogen in an available form, sulphur (existing as FeS_2), oxygen, nitrogen, and the constituents of the ash.

All coals naturally contain a certain percentage of water, and in practical analysis this water should be eliminated and all results calculated on the *dry material*.

The valuation of a sample of coal refers to the determination of its calorific or heating power, and is based upon the "calorie," or quantity of heat required to raise one kilogramme of water through one degree Centigrade, or the unit of heat may be regarded as the quantity of heat necessary to raise one pound of water through one degree Centigrade.

The only elements that determine the calorific value are the carbon and hydrogen. The carbon includes both the fixed and the volatile, and the sum total of both may be determined at the same time, together with the hydrogen.

But the determination of the "fixed" as distinguished from the "volatile" carbon is often a satisfactory and necessary item. A coal may carry 90 per cent. pure carbon, but, if 30 per cent. of this is volatile, and only 60 per cent. fixed, a serious loss may occur should part or all of the volatile carbon be carried off into the air. In other words, much depends on the style of furnace employed. A smoke-burning furnace will consume the above volatile carbon so that no heat will be lost.

The same is the case with the hydrogen, which generally forms a large part of the volatile portion of coal, and which would be partially lost except in smoke burning furnaces.

The above refers particularly to "soft" coals, which always contain a large amount of volatile material, and in the employment of which smoke-burning furnaces are a positive economy.

Soft coals contain a percentage of volatile material varying from 12 per cent. to 30 per cent., with an ash amounting to no less than 4 per cent. or more than 7 per cent. This matter consists of the heat-giving elements carbon and hydrogen, together with oxygen, nitrogen, sulphur, etc.

The oxygen and nitrogen are the result of decomposition of organic bodies in the coal, although some of each may be naturally occluded in the coal in a free state.

The sulphur rarely amounts to more than one-half per cent., though it may often run as high as 1½ per cent.; it is supposed to exert but little influence against the heating power, but it certainly does no possible good.

Hard coals, on the other hand, rarely carry over 5 per cent. of volatile material. As in soft coal, this consists of hydrogen and volatile carbon, together with a little sulphur.

Most of the carbon in good anthracite coal is "fixed," the excess of total carbon over the fixed being rarely over 2 per cent.

As the hydrogen is correspondingly small, but little loss occurs in our common furnaces.

Regarding as our *heat unit* the heat necessary to raise the temperature of one pound of water through one degree Centigrade, one pound of carbon (C) in burning to carbonic acid (CO_2) disengages 8,080 thermal units, and one pound of hydrogen (H) in burning to water (H_2O) disengages 34,460 thermal units. The great difference in the heating powers of C and H, as here indicated, shows that enormous differences may occur in the great number of coals offered in the market, their value depending on the relative percentages of carbon and hydrogen.

In general soft coal runs higher in heating power than hard coal, on account of the higher percentage of available hydrogen, and yet, notwithstanding this fact, it very often happens that an anthracite coal yields more heat than a bituminous. This may occur when the carbon is very high, and the percentage of ash very small. But the larger percentage of hydrogen in bituminous coals renders them the great heat producers, while their relatively lower market value is an additional incentive for their purchase by large factories.

The physical phenomena presented by burning coal may be noted as readily in the laboratory as in the furnace; indeed, its deportment should be recorded among the results of an analysis.

Coal is often distinguished as caking or non-caking. The former when, on being heated at a moderate temperature, it forms almost imperceptibly a hard, brittle cake; the latter, when no such phenomenon is presented. Many bituminous coals are caking, while others, instead of caking, swell up and fuse.

The anthracites are the non-caking coals; they present no characteristics worthy of note during the early stages of combustion.

Among the bituminous coals, those that swell up and fuse, taking curious shapes and presenting a volcanic appearance, contain the highest percentage of volatile matter. Most of our American coals containing from 16 to 25 per cent. of volatile material belong to this class, while the bituminous, carrying 15 per cent. and less, generally show the caking phenomenon.

The coals found in the market to-day vary from a heating power represented by 6,000 calorific units to that of 9,000. The average heating power of bituminous coals is 8,500, and that of anthracites in the neighborhood of 8,000. But these often run higher in many individual cases.

The following tabulated series of analyses will give a fair average of soft and hard coals, as regards both chemical and physical characteristics:

BITUMINOUS COALS—CUMBERLAND.

Ash.	Vol. matter.	Sulphur.	F. C.	T. C.	Hydrogen.
1. 5·41 %	13·90	0·40	80·7	85·95	4·83
2. 4·61 "	16·035	0·49	79·11	82·0	5·65
3. 6·37 "	14·94	0·45	78·70	83·0	5·10
4. 7·35 "	19·90	undetermined.	72·75	78·3	6·00

The heating power of No. 1 = 8,610
" " " " No. 2 = 8,564
" " " " No. 3 = 8,464
" " " " No. 4 = 8,394

The ashes of the Cumberland coals were of a grayish and reddish-gray color.

No. 1 Caked with no tendency to fuse.
No. 2 " " " " " "
No. 3 " " " " " "
No. 4 Fused and swelled up.

The important part played by hydrogen may be fully appreciated by a comparison of the analyses. No. 1, although carrying nearly 86 per cent. pure carbon with 4·8 per cent. of hydrogen, had a calorific power of 8,610; while No. 4, with only 78 per cent. carbon, yet, as it carries 1½ per cent. more of hydrogen, has a heating power within 200 units as high as No. 1. But much loss of heat would occur in No. 4 with other than smoke-burning furnaces, hence it might be economy in this case to employ No. 1, with 5 per cent. less of volatile matter.

ANTHRACITE COALS.*

Ash.	Vol. matter.	Sulphur.	F. C.	T. C.	Hydrogen.
1. 9·70	4·70	0·284	85·31	Undetermined (very small).	Undetermined (very small).
2. 11·25	5·10	0·031	83·62		
3. 3·36	2·90	0·238	93·50		
4. 1·90	1·88	0·021	96·19		

In No. 1. Pounds of water evaporated by 1 lb. coal = 8·82
In No. 2. " " " " " " " = 11·70
In No. 3. " " " " " " " = 11·00
In No. 4. " " " " " " " = 10·36

The heating powers of these are expressed in other terms. In No. 3 and No. 4 are shown good specimens of those hard coals which yield as much heat as many bituminous coals. These are all non-caking coals.

PRACTICAL ANALYSIS

1. *Sampling.*

The sample should represent an average of the whole quantity—no less than one pound can be used. This must first be ground in an iron mortar and sifted through a fine sieve. What remains must again be ground and sifted until all passes through.

2. *Estimation of Water.*

Weigh off 3 grammes of the powdered sample, and heat in air bath at 120° C. for twenty minutes; then weigh (after cooling). Afterward heat up again, weighing every ten minutes till weight is constant.

Loss in weight = water.

Note.—Bituminous coals increase in weight by oxidation during the heating, so too great care cannot be exercised in this part of the analysis.

Unless the percentage of water is specially desired, it need not be regarded. Under all circumstances it is best to calculate all results in the dry material, for which purpose heat up the sample for forty minutes and place in desiccator to cool.

3. *Volatile and Combustible Material.*

Place the dry sample in a weighing flask. Deliver from it 0·500 g. coal into a porcelain crucible, and heat for ten minutes over the strongest Bunsen burner, the crucible being kept covered all the time. Cool and weigh.

Loss = volatile and combustible material + ½ the sulphur of the FeS_2.

4. *Fixed Carbon.*

Take from the weighing flask about 0·500 gr. and place in a tared, open platinum dish. Heat gently at first over Bunsen burner, then more strongly, and finally at highest heat, until all the carbon is burned off.

Loss = volatile matter + ½ S + F. carbon. The difference is the fixed carbon. The residue = ash.

Note.—Examine ash closely as to color and texture.

5. *Sulphur.*

Oxidize 2 g. of coal with 20 c. c. fuming nitric acid and ½ g. chlorate of potash in a porcelain dish. Cover with inverted funnel for two hours at a very low heat. Bring on to a filter, wash with boiling water, and precipitate with $BaCl_2$.

Wash the precipitate in acetate of ammonia by boiling up with it and decanting several times.

From the $BaSO_4$ calculate the sulphur.

6. *Estimation of Total Carbon and Available Hydrogen.*

Employ a hard, infusible glass combustion tube 40 cm. long and about 15 mm. in diameter, drawn to a point. Fill ⅓ the length with *dry fused chromate of lead finely powdered*. Then by means of a small delivery tube insert 0·200 g. of coal into the combustion tube. Mix well the coal and chromate by means of a wire stirrer, and finally add more chromate, stirring still, until the tube is filled to the extent of 35 cm.

At the anterior end place a thick coil of copper gauze, to decompose the nitrous oxide that may be formed.

Then attach a chloride of calcium tube, carrying two bulbs, to the tube by a rubber cork. To the chl. of calcium tube attach a U tube containing nitrate of lead, to catch the sulphurous acid formed, and lastly the potash bulbs filled with strong caustic potash.

Proceed carefully as in any other delicate organic analysis, keeping the copper gauze at a bright red heat. The posterior part of the chromate should be heated the hottest.

From the increase in weight of the potash bulbs calculate the total carbon (fixed and volatile) and from the $CaCl_2$ tube the hydrogen.

Note.—Never use more than 0·250 g. of coal. In coals carrying as high as 20 per cent. of volatile material, 0·100 g. is sufficient.

Too much care in using *dry* chromate of lead cannot be exercised, otherwise too much hydrogen will be set down for the coal.

7. *Valuation in Heating Power.*

Multiply the percentage of total carbon by 8,080, and the available hydrogen by 34,460. Divide each result by 100, and add together.

Example.—Coal contains 80 per cent. carbon, 5 per cent. hydrogen. Hence,

$$\frac{(80 \times 8{,}080) + (5 \times 34{,}460)}{100}$$

646 4·00
172 3·00

818 7·00 = calorific or heating power.

As a further means of comparison, it is often advisable to record the amount of coke yielded by a given sample. The coke is the difference between 100 per cent. and the volatile matter.

Beyond the above analysis, nothing is wanted to enable one to form a right judgment as to the value of a coal.

* Cat. Min. and Agric. Prod., Phila. & R. R.R., 1876.

CHEMICAL ACTIONS WITH CARBON AND ITS COMPOUNDS.*

By G. Gore, LL.D., F.R.S.

The following experiments were made partly with the object of finding some new reactions in which carbon was set free in the elementary state, and also to discover new facts respecting carbon and some of its compounds:

1. White phosphorus was added in very small fragments at a time to potassic cyanide in a state of fusion; strong effervescence occurred. On dissolving the cooled mass in water a small quantity of black matter was left. The black matter was insoluble in a hot mixture of nitric and hydrofluoric acids; it burned with a glow, without flame, and left hardly a trace of residue; it was therefore carbon, and may have been derived from potassic carbonate contained in the cyanide. (Compare experiments 2 and 3.)

2. Red phosphorus in a state of powder, added to potassic cyanide in a state of fusion, produced strong action, and caused the cyanide to become black; and upon dissolving the cooled salt in water much black powder of low specific gravity separated. Powdered arsenic also caused the separation of a small amount of black matter from the fused salt. Powdered antimony had a similar effect.

3. A mixture of pure potassic and sodic carbonates in a fused state was not visibly decomposed by metallic arsenic or antimony; but by aluminum carbon was separated.

4. When carbonate of sodium at a low red-heat was decomposed by vapor of phosphorus, if the residue was not finally heated so as to expel all free phosphorus, on subsequently dissolving it in water a dark brown liquid was obtained, the blackness of which could not be entirely removed even by a large number of successive filtrations. The black matter in the filter required extreme washing in order to obtain a colorless filtrate.

5. By adding phosphide of sodium to a fused mixture of the pure carbonates of sodium and potassium a little incandescence occurred, and a black, coaly-looking substance was obtained. The cooled substance on being thrown into water evolved a very small amount of spontaneously inflammable gas. The experiment was repeated with the previous addition of zinc to the salt. In each case, on treating the residue with water, a black powder was obtained which burned readily and left no residue.

6. By projecting small portions of a mixture of red phosphorus and ammonic carbonate, each in a state of powder, into a red-hot porcelain crucible, fused phosphoric acid of a blackish color was obtained.

7. No carbon was set free by adding ammonic carbonate to fused sodium in a wrought-iron cup; scintillation only took place when the carbonate touched the melted metal.

8. Metallic sodium was added to melted potassic cyanide; it floated, burned, and disappeared. On treating the cooled mass with water a minute quantity only of black matter separated.

9. A piece of potassium and a small quantity of bisulphide of carbon were highly heated in a lightly closed glass tube, and shaken. The glass became filled with green vapor of potassium, portions of the contents became red-hot, and the tube burst with a loud report.

10. Coal-gas was passed over red-hot peroxide of iron in a state of fine powder; it set free metallic iron and carbon as a fine black powder.

11. By passing coal-gas over fused argentic fluoride in a platinum boat at an incipient red-heat all the silver salt was reduced to metal, hydrofluoric acid was formed, and a little carbon was separated as a black powder mixed with the unfused silver.

12. Coal-gas was passed over argentic chloride just below its fusion-point, also over chloride of lead in a state of fusion, until the salts were quite reduced to metal. In each case, but most with the silver salt, carbon in the state of a fine black powder was set free, and was obtained on dissolving the residue in dilute nitric acid. The chlorides of copper

* Read before the Birmingham Philosophical Society, June, 1884.

and cadmium were similarly treated; the former was slowly reduced and some carbon liberated; the latter was not decomposed.

13. By passing coal-gas, during several hours, over fused iodide of silver in a glass retort, at a red heat, only a comparatively small portion of the salt was reduced to the metallic state; no carbon was detected.

14. A mixture of tetrafluoride of silicon and carbonic anhydride was passed through a red-hot glass tube. No silica was produced nor carbon set free. By passing also a mixture of carbonic anhydride, phosphureted hydrogen, and vapor of carbonate of ammonium through a similarly heated tube, no carbon was liberated.

15. Mixtures of carbonic anhydride and hydrogen, carbonic oxide and hydrogen, and of all three of these gases, were passed through red-hot glass tubes, and also over red-hot platinum-foil, but in no case was either vapor of water formed or carbon eliminated. By passing a mixture of carbonic anhydride and hydrogen through a red-hot iron tube containing iron turnings, no decomposition occurred.

16. No carbon was liberated by long-continued contact of carbonic anhydride gas with a solution of white phosphorus in carbonic bisulphide. Pieces of white phosphorus in water exposed to an atmosphere of carbonic anhydride in a dark place, during nine weeks, showed no sign of change.

17. Silicon in contact with pure gold in water exposed to carbonic anhydride showed no visible change in six weeks. With vapor of CCl_4, instead of carbonic anhydride, the results were the same. With magnesium in absolute alcohol exposed to carbonic anhydride gas, no carbon was liberated.

18. By condensing carbonic anhydride in the liquid state at 60° F. into contact with potassium and sodium, no carbon was set free.

19. By passing vapor of selenium slowly over a layer of charcoal powder, 8 inches long, in a thick refractory glass tube, at a full red heat during one hour and a half, about three drops of a liquid were obtained. Several experiments of this kind were made, and in one of them the liquid dissolved some of the selenium, and formed a thick oil, of a red-brown color.

20. Potassium which had been kept immersed in excess of liquid C_2Cl_4 in a closely stoppered bottle during four years, became wholly converted into a soluble white salt of strongly alkaline reaction. No carbon was separated.

21. By bringing into contact either of the four chlorides of carbon, bromide of carbon, carbonic bisulphide, pure anhydrous carbonate, or formiate of sodium, or ammonic oxalate, with a deep blue solution of potassium or sodium in anhydrous liquid ammonia under pressure at 60° F., chemical changes occurred; the liquid was decolorized, soluble salts were formed, but no carbon was liberated in either of the instances.

22. By passing dry ammonia gas through liquid C_2Cl_4 containing potassium, gas was caused to evolve from the surface of the metal, and a red powder was precipitated. By using Persian naphtha instead of the chloride of carbon some ammonia was dissolved, and the potassium only became red on its surface. Potassium in amylene evolved gas freely.

23. Lampblack, also well-burned wood charcoal, was insoluble in anhydrous liquefied cyanogen, but the chlorides and sulphide of carbon were freely soluble. Lampblack was also insoluble in liquid chloride of sulphur, terchloride of phosphorus, or boiling pentachloride of antimony.

24. Carbon was not consumed by being heated to redness in contact with argentic fluoride; if, however, chlorine was present, the carbon disappeared.

25. By experiment I found that carbon was insoluble in anhydrous hydrofluoric acid at 32° F.; also in anhydrous hydrochloric acid, or carbonic acid, each in the liquefied state under great pressure at 60° F. Carbon which had been reduced from vaporous carbonic bisulphide by means of red-hot potassium or sodium, dissolved slightly in boiling nitric acid, and formed a brownish liquid.

26. Neither carbonic bisulphide nor either of the chlorides of carbon would dissolve in, or unite with, liquefied anhydrous hydrofluoric acid, nor was either of the four chlorides of carbon perceptibly soluble in concentrated hydrochloric acid.

27. A vessel filled with carbonic anhydride was inverted over strong aqueous hydrofluoric acid at 60° F., during thirty-six hours; scarcely any of the gas was absorbed.

28. A saturated solution of sulphur in bisulphide of carbon, also one of phosphorus in that liquid, were each inclosed in separate glass globes filled with carbonic anhydride, and kept in the dark during two months. No signs of any chemical change took place.

29. A thin wire of platinum was twisted round a thick one of pure tin, and immersed in purified carbonic bisulphide during nine weeks. No visible change occurred. This is a process which some one had published as an artificial one for producing diamonds.

30. In carbonic bisulphide, silver in contact with platinum became quite black in three weeks. Magnesium in contact with that metal was unaffected in ten weeks. Lead in contact with mercury during two years formed a black powder which was entirely soluble in dilute nitric acid.

31. Bisulphide of carbon was not decomposed by a current of gaseous terfluoride of boron. Tetrachloride of tin, also bichloride of titanium and cyanogen gas, was found to be freely soluble in carbonic bisulphide. A solution of iodine in the same liquid was decolorized by a stream of hydrogen.

32. By contact of potassium with platinum in a solution of sulphur in bisulphide of carbon, during a long period, the platinum received no carbon deposit; zinc remained bright.

33. Bright metallic thallium rapidly became black in pure carbonic bisulphide which had been redistilled twice from lead carbonate and porous chloride of calcium. After a period of two years no carbon was separated.

34. Carbon bisulphide instantly precipitated a solution of mercuric chloride in ether.

35. Aluminum became dull, but did not corrode or form crystals, in a solution of phosphorus in carbonic bisulphide, during two years; magnesium behaved similarly.

36. Platinum alone was partly immersed in aqueous solution of argentic nitrate in contact with vapor of carbonic bisulphide. Slow decomposition occurred. In seven weeks the silver was apparently all precipitated as an abundant black powder. No deposit formed upon the platinum wire except just beneath the surface of the liquid.

37. Magnesium, aluminum, or silver, partly immersed in water exposed to vapor of carbonic bisulphide, showed no change in seven weeks; but with silver in contact with platinum, under the same condition, the liquid became dark in color, and the silver above it blackish, during that time. The same metals, similarly prepared, but with vapor of CCl_4 instead of the sulphide, showed no change during the same period.

38. Magnesium in contact with gold, in water exposed to coal-gas during seven weeks, yielded no deposit except magnesia.

39. Magnesium alone was immersed in amylene; in amylene mixed with some glacial acetic acid in a mixture of absolute alcohol, with acetone, with valerianic acid, with oxalic and acetic acid, with crude vegetable naphtha, with the crude distillate from wood after neutralization by lime; also in a mixture of glacial acetic acid with sulphuric ether, with benzine, and with toluol, each during several days; no carbon was liberated.

40. An alloy of magnesium and thallium was immersed in liquefied glacial acetic acid, and in a mixture of absolute alcohol and acetic acid; an amalgam of mercury and a little sodium was also immersed in semi-glacial acetic acid; each during several days, without separation of carbon.

41. Magnesium in contact with platinum was immersed in mesitylene (five weeks); in mesitylene and vegetable naphtha (four days); in heavy wine oil (seven weeks); in an aqueous solution of sulphovinate of potassium (nine days); in a solution of naphthaline in vegetable naphtha (four days); it was also immersed (and so also was aluminum), in contact with platinum, in a mixture of absolute alcohol and glacial acetic acid (three days); both in absolute alcohol and with spirit of wine with xylol (two days each); in a solution of dry malic acid in absolute alcohol (two days); and in each case the result was similar to the above.

42. Crystals of silicon and of boron were immersed in a moderately strong solution of carbonate of rubidium at 60° F., in a glass bottle, during two months. No visible chemical effect occurred.

43. Crystals of silicon in contact with platinum dissolved slowly in a mixture of solution of sodic carbonate and hydrate during two years, and left a skeleton of impurity. They also, and aluminum, dissolved slowly in a solution of potassic cyanide; selenium dissolved less slowly, while magnesium and boron were unaffected, and white phosphorus became very slowly blackened. White phosphorus, when in contact with platinum, in a solution of potassic carbonate, in a flint-glass bottle, caused the glass to become black on its surface in two years.

44. Numerous experiments were also made of immersing white phosphorus, magnesium, aluminum, silicon, and boron, in contact with platinum, palladium, gold, silver, iron, etc., in solutions of the carbonates and bicarbonates of potassium and sodium, the formates and oxalates of these metals, during various periods of time, extending in many instances to two years; also in water, glycerine, solutions of sodic hydrate and potassic chloride, exposed to coal-gas, carbonic oxide, carbonic anhydride, carbonic bisulphide, vapor of CCl_4, and in water containing solid chloride of carbon; but in no case was carbon separated.

PROSTHETIC ARTICULATION.*

By H. L. Cruttenden, D.D.S., Northfield, Minn.

In this paper I will endeavor to give my way of operating with a new instrument—an articulating guide.

After an accurate impression of the mouth has been secured, obtain a correct "bite," at the same sitting, in order to form the articulation, the casts for which are to be set in an adjustable metal articulator. At the same sitting place the articulating guide in the mouth in such a manner that the cap, A (Fig. 1), will press up against the hard palate, and the projections, B C, rest against and outside of the upper gums, at or near the position of the cuspids, with the part, L, directly in front of the median line. The jaws are then properly closed, and the lower projection on the slide, F, is placed against the outside of the lower gums,, or teeth, as the case may be. When the sliding projections, B C, are once set at the proper distance on the bars, M M, to let the cap, A, press against the center of the hard palate, there is seldom need of changing their position on the bars, except in the case of a very large or small superior maxilla.

The cap, A, is raised or lowered in the graduated tube to conform it to a high or low palatine arch, and should be so adjusted that, when placed in the mouth, the bars, M M, will be horizontal, or nearly so. The vertical distance from the upper surfaces of the slides, B C, to the under surface of the slide, F, should be the length of the "bite," and such adjustment is effected by raising or lowering the lower bar, K, at the binding screws, G and H, so that K shall be nearly parallel with M M. The operator should stand at the right side of the patient, and, holding the appliance in position with the left hand at C, require the patient to repeatedly open and close the jaws until the several parts shall have been properly and exactly fixed as previously described.

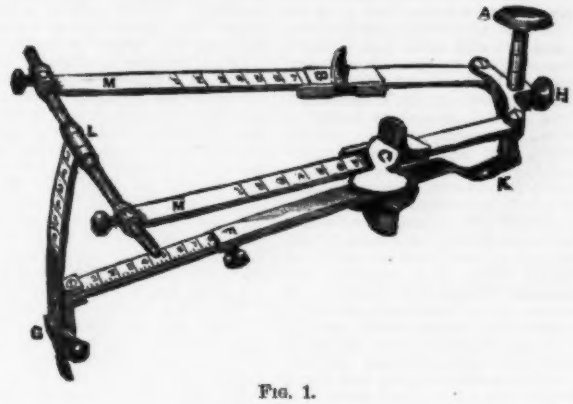


Fig. 1.

Fig. 2 shows the instrument *in situ*. A record of the measurements may be made to guard against accidental displacement of the parts, or to permit the use of the guide for another case; and Fig. 3 is a diagram of such a record.

The 3 above the line represents the height the cap, A, is raised out of the graduated tube; 1 is the distance the tube is above the block; 7 is the place at which G is set. (The measurements at D and E are usually at 2; so I never record them unless set at some other mark.) The 8 is the number

Fig. 2.

of the notches the springs on the slides, B C, rest in, and 6¼ is the exact measurement on the lower graduated bar at F.

Fig. 4 shows the guide in place on the articulated models or casts, and by this means the correctness of the "bite" may be either verified or proved incorrect, and if the latter, a readjustment the articulator can be made to precisely adapt the relative positions of the models to the exact measurements of the guide. Fig. 4, as also Fig. 2, shows teeth in the lower jaw; but in cases where those teeth are either

Fig. 3.

Name			
3. / 1.	7.	8.	6¼

partially or completely wanting, the guide will be found equally well adapted for measurement, as previously explained.

When the articulation is tested by the guide, and the cast of the lower law does not rest *inside* of the projection on the lower slide (F), it is evident that the patent has, in biting, protruded the jaw as much as the measurement indicates, for the jaw has once been inside the projection, and therefore the guide must be correct, since one cannot close the jaw further back than is natural; yet when found very much out

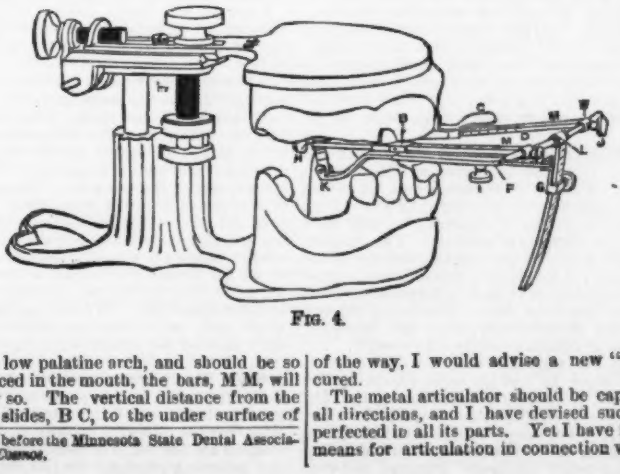


Fig. 4.

of the way, I would advise a new "bite," if it can be secured.

The metal articulator should be capable of adjustment in all directions, and I have devised such a one; but it is not perfected in all its parts. Yet I have found it a trustworthy means for articulation in connection with the guide.

* Abstract of a paper read before the Minnesota State Dental Association, July 16, 1884.—*Dental Cosmos.*

OPIUM SMOKING.

THE practice of smoking opium for the purpose of producing a false excitation, a half-sleep accompanied with agreeable dreams, had long existed in India and Persia when the English, toward the close of the last century, thought of introducing it into China. In 1785 the India Company exported to the Celestial Empire more than 4,000 cases of opium, representing a total of about 300 tons of 2,200 pounds. The habit extended so rapidly, and at the same time gave rise to so unquieting effects, that the Chinese government was obliged to fight against it, and to forbid, under pain of death, the consumption of a drug that was recognized as so pernicious. Smuggling continued to throw vast quantities of the prohibited merchandise into the empire, however, and the process by which it was done is related by Lafond as follows: "The smugglers operated openly. . . . In the afternoon their boats, which were light and slender, and manned by from sixty to eighty oarsmen, prowled along the coast, watching for a favorable moment, which, skillfully seizing, they shot out like a flash and succeeded in reaching a ship. In the twinkling of an eye the opium was taken out of the cases and the balls were passed from hand to hand to the Chinese sailors, who took them on board with wonderful address. These balls, weighing about three pounds, were small enough to be hidden and landed with facility. All the smugglers had the upper part of the body naked, and the face covered with a black silk handkerchief, not only as a disguise, but also to protect themselves from the smoke of the gunpowder fired at them by the customs officers." Owing to the complicity of the mandarins, they had rarely to fear anything else, in fact, than a few blank shots. But if the affair became more serious, each one jumped into the water, carrying his supply of opium with him, and the captain, showing the visitors a boat free from suspected goods, could not be disturbed. In 1839, however, the magistrates resolved to make an example, ordered the public execution of a Chinaman who had been convicted of the fraud, and the destruction of 20,000 cases of opium that belonged to the English and had been landed by them. The English did not hesitate to defend the great benefits of their illicit commerce by force. This people, so jealous of its own liberty, but having so little respect for the rights of others, when such rights interfere with its mercantile interests, extorted, at the cost of a war (1840–42), from a weak and disarmed enemy, and with an indemnity of more than a hundred millions, and the possession of Hong Kong, an imperial authorization to sell its opium in certain ports. In 1864 its ships introduced into China more than 3,000 tons of ium, in 1866 nearly 4,000, and in recent years these figure. nave been much exceeded! The Chinese are passionately fond of smoking opium, and in order to procure the material at a lower price, they have begun the cultivation of the poppy upon a large scale in the southern provinces.

Now we find the English themselves smoking opium and consuming morphine! It is the beginning of a just return of things here below. A day will perhaps come in which these too covetous merchants will be obliged to go to China to buy a product that the excess of consumption will have rendered insufficient in their own markets. The English have not failed to protest against the assertion that the effects of opium are pernicious. According to some of them, opium smoking is a beneficial habit, or at least a harmless one, and this opinion has more than once found an echo among ourselves. "Nothing can demonstrate," says Mr. Morache, "that a moderate use of opium is really injurious. . . . But if, unfortunately, the smoker allows himself to go to such a verge that, in order to feel the same effects, he has to take more and more, his digestive functions in the first place and then the cerebral ones (intelligence and innervation) will feel the effects of it. The same succession of phenomena occurs as in alcoholism, and from this it is natural to suppose that the action is nearly identical. Perhaps, however, the troubles remain longer, limited in the functions of nutrition. It is not rare to meet with opium smokers who have for years been reduced to a characteristic emaciation, who have the dyspepsia badly, whose intelligence, a little slow perhaps, awakens very well under the influence of the drug, and who in this state of excitement perform prolonged intellectual work. Sooner or later, however, they fall into a state similar to that of chronic alcoholism, with the same general phenomena—convulsive attacks and finally general paralysis." Other authors portray the effects produced by opium with darker colors, and we are inclined to believe that they come nearer the truth.

Large numbers of Chinese begin to smoke opium from childhood. The doses are at first small, but they gradually become larger and more repeated. Certain individuals consume as much as three or four drachms per day. Some reach such a result at the end of two years, when they have scarcely attained an adult age. Toward the age of forty or forty-five, the smoker is often reduced to the last degree of marasmus, and is dead to social life. He is a sort of pale, fleshless specter, with an atonic, vitreous look. He dies amid sufferings that the narcotic no longer calms, devoured by a hunger that he is no longer in a state to satisfy. The figure which we place before our readers, and which is a very exact reproduction of a photograph taken at Saignon, shows that there is nothing fanciful about this picture.

The opium smoker is the slave of his passion. If he tries to break with it, without minute precautions, he runs the risk of succumbing to the effects of a quick poison, just as the symptoms of an intoxication are seen to occur in arsenic eaters at the moment they cease to consume arsenic. But it is rare that the opium smoker gives up his habit voluntarily, and he never suffers any interruption in it unless he cannot buy the drug; but, before being reduced to such an extremity, he will use all means, lawful or otherwise, to procure that which has become his food. He is not the only one to suffer from so detestable a passion. Opium is expensive, and the time passed in consuming it is necessarily profitless. In order to pay for opium, money is made out of everything, and wife and children, when they are not sold, are abandoned to misery.

AN OPIUM SMOKER. (From a Photograph.)

This is not all. The degeneracy of the individual is transmitted to his descendants, the race degenerates, and decadence becomes imminent. Who will ever be able to say in what measure the introduction of opium into China has contributed to the ruin of that great nation?

For those who might pretend that we are exaggerating the traits of our picture, we terminate this note by the following extract from a recent memoir of Dr. Macgowan, of Wenchow:

"The customs reports for 1881 show first, that, taking 3 *mace* per day as the mean quantity of opium consumed by each individual, the foreign market would suffice to supply only one-millionth of the population; second, that the population of China is about 300,000,000; and third, that the indigenous production is at least equal to the importation. Consequently, the smokers of opium represent only a third of one per cent. of the population. In admitting as a rule (and the exceptions are very rare) that the male element of the population is alone addicted to this habit, and that no subject below the age of twenty has yet become a victim to it, we get a more precise idea of the number of smokers, for we know that the number of men over twenty years of age is about 60,000,000. We may say then that 1 out of 60 of the adult male population consumes foreign opium, and the same number the indigenous drug. In other words, 3½ per cent. of the male population over the age of twenty smoke opium. My own researches in regard to the indigenous consumption would tend to prove that it is more than four times greater than that of imported opium. . . . If we consider that the offspring of the opium smoker who has not yet reached the last stage of decrepitude is certainly degenerate, and inherits a penchant for this degrading habit, the magnitude of the evil seems to defy the calculations of the statistician and escapes the appreciation of the political economist.—*Science et Nature.*

SANITARY EXAMINATION OF DRINKING-WATER.*

By Prof. EDMUND R. ANGELL.

THE aim of the following article is to furnish every intelligent person with sufficient information to enable him, with trifling expense, to determine approximately the quality of the water which he drinks daily. It is not an easy matter to reduce the operations of water analysis to such simplicity that they may be readily used, and give accurate results; but it is believed that the methods brought forward in these pages, if carefully and patiently applied, will give in most cases reliable information concerning the sanitary condition of water; and it is hoped that the subject is presented in such a way as to be the means of awakening more interest in this very important subject. For when it is considered that three-fourths of the human body is water, the need of maintaining the supply from pure sources begins to be realized. It is well known that thirst prostrates one sooner than hunger; the larger portion of the system evidently makes the more important demand. But water is no more necessary to life than pure water is to health. Because persons have drunk questionable water and still live, is no sign that they would not have lived better on pure water: because one survives a dose of poison, is no reason that poison is good, or even harmless.

How much poison is taken into the system from impure water it is difficult to say, but it is certain that experience and science, again and again, have traced sickness and death to this source; and it is reasonable, if badly polluted water causes severe and fatal disease, that slightly impure water may slowly undermine the health by being the cause of a host of ailments and inabilities of body for which the sufferer finds no apparent cause.

Let him who is afflicted in this way turn his attention to the various sanitary conditions of his surroundings, and especially to that of the water he drinks, that he may know whether or not every draught that quenches his thirst shortens his life; and let him who thinks he knows no ill, do the same, to the end that he may live many days free from evil.

Water may be injurious to health because it contains decomposing organic matter, either animal or vegetable, or because it contains some poisonous metal, usually lead.

In examining water, the first thing likely to be noticed is its appearance. Generally, polluted waters have various shades of a yellowish or brownish tint, which vary according to the amount of filth which they contain; but to this there are so many exceptions, that the color is by no means a safe guide. Some peaty waters, and those that contain iron, may have a yellowish or brownish tint, and yet be perfectly healthy. On the other hand, some very badly polluted waters are perfectly clear, and frequently present a better appearance than many pure waters.

The character of a water can seldom be determined from any one indication or test. The accumulated evidence of a number of tests is necessary for the formation of a correct opinion of its quality. Occasionally, from the most accurate and numerous tests that can be made in a fully equipped laboratory, it is impossible to pronounce on some waters, while others are so marked in character that a few tests declare at once what they are.

THE ODOR OF A WATER.

The smell of a water often gives some indication of its character. But it frequently happens that wholesome waters have an unpleasant odor: this is the case with some mineral waters. In clayey districts especially, water which is organically pure may have an objectionable odor which is imparted by the clay. The waters of some lakes and rivers which supply some of our large cities, as Boston, New York, and Baltimore, have at times a peculiar "fish-like" odor. It generally begins in summer, but sometimes not until autumn. It is due, probably, to some condition of water plants—whether to a state of growth, or decay, is uncertain. Growing plants emit odors peculiar to themselves: so it is not necessary to suppose that the odor mentioned arises from decay. However it may be, there is yet no evidence that such water is injurious to the health of those who drink it.

TO DETECT THE SMELL OF WATER.

If the odor is very marked, of course there is no difficulty in perceiving it; when this is not the case, partly fill a clean bottle with the water to be tested, and after shaking it violantly, so as to communicate the odor to the air within the bottle, place it in a kettle of cold water, and heat the whole together. Heat expels the gases dissolved in the water so that they may be detected. Finally the odor may be made more apparent by adding a little caustic potash to the water.

THE SUGAR TEST.

An easy and quite reliable test for organic matter in water is this: Add about ten grains of pure granulated sugar to about five ounces of the water to be tested; the bottle should be completely filled, and the stopper tightly fitted, so as to exclude the air. Expose the water to daylight and a temperature of about seventy degrees Fahrenheit. If it contains much organic matter, an abundance of whitish specks will appear within a day or two, floating around in the liquid. Of course the more organic matter there is, the more marked the appearance. These little bodies are best observed by holding the bottle against something black, or by partly shading the farther side of it with the hand. After a while they will group themselves together in bunches, and partly settle to the bottom of the bottle; at length, if the water is very bad, the odor of butyric acid (the smell of rancid butter) becomes perceptible.

CHLORINE.

This is a constituent of common salt, and is very widely distributed in nature. Good water on an average contains perhaps from 0·4 to 1·0 grain of chlorine per gallon. If a water contains more than this amount, it is a strong indication that it has received pollution from cesspools, sink-drains, or the excreta of animals, all of which are highly charged with salt. But some localities, especially those near the sea, contain more salt than others; so that a good water in those districts may contain five, or even ten, grains of chlorine per gallon, for that is the natural amount. Before one could pronounce with some confidence on the sanitary condition of a water from the determination of chlorine alone, it would be necessary to know the average amount of it in the natural waters of the region; hence, if in a single

* From Third Annual Report of the N. H. State Board of Health.

instance a water contains more than the general average, and there are no other indications of impurity, it would be unwise to condemn it. On the other hand, it would be equally unwise to pronounce a water safe if it contains less than the average amount of chlorine; because waters very badly polluted with vegetable matter alone are deficient in chlorine. However, when chlorine is deficient it is certain that there is no contamination from animal matter.

It is possible for waters to contain salt that has come from filth, without containing the filth itself. When this is the case, one of two conditions exists: it may be indicative of a past pollution, or a warning of coming danger. Filth that had previously found access to the well may have undergone complete decomposition, while the salt remains; or filth may be so far from the well that nothing but its salt is washed through the intervening earth into it. Both conditions render the well unsafe, for in the one case another inflow of filth is liable to occur; in the other, the soil may soon become too fully charged with it to retain it all.

THE ESTIMATION OF CHLORINE.

To determine the approximate amount of chlorine, it is necessary to prepare a standard solution of salt. One ounce avoirdupois, 437·5 grains, of pure salt contains 265·5 grains of chlorine. If this be dissolved in 17·7 fluid ounces of water, each drop of the solution, reckoning 480 drops to the ounce, ought to contain $\frac{1}{32}$ grain of chlorine, since $(265{\cdot}5 \times 32) \div 480 = 17{\cdot}7$.

Weigh, as carefully as possible, one ounce avoirdupois of best table salt; dissolve it in eighteen ounces of clean rain-water. This solution will contain very nearly $\frac{1}{32}$ grain of chlorine per drop. The greatest care should be exercised in dropping the fluid, since the size of a drop varies so much. It should be dropped from an ounce bottle, and the drop allowed to form slowly.

Prepare a very weak solution of nitrate of silver, by dissolving a crystal, not larger than half a pea, in about one ounce of pure rain-water. There will be hardly any risk of making this solution too weak. Also prepare a solution of chromate of potash; bichromate of potash will answer the purpose if the chromate cannot be obtained. The solution should be made in rain-water. The strength of it is not important.

APPLICATION OF THE TEST.

Pour four ounces of the water to be tested into a saucer, and add enough chromate of potash solution to impart a distinct yellow color; then add a drop of the silver solution; a red color is produced where the drop strikes, from the formation of chromate of silver, which is quickly destroyed if the water contains much salt; continue to add the solution of silver drop by drop, counting the drops, and stirring the water after each additional drop, until it assumes a faint reddish tint, which will occur as soon as all the chlorine has been precipitated. Then pour four ounces of clean rain-water into another saucer, add one drop of the solution of salt, observing the precaution already given about the size of the drop, and proceed as before. If it takes a larger number of drops of the silver solution to produce a reddish tint in this than were required to produce it in the other case, the water tested contains less than one grain of chlorine per gallon, since $\frac{1}{32}$ grain in four ounces of water is at the rate of one grain in 128 fluid ounces, or one gallon. If more drops of the silver solution were added to the water than to the fluid used for comparison, it is easy, from the number of drops added to the latter, to estimate the chlorine in the former. For example, suppose ten drops of silver solution represent one grain of chlorine per gallon, and the water in question requires thirteen drops; then it contains 1·3 grains of chlorine per gallon. From this it will be seen that if the solution of nitrate of silver is sufficiently weak, it is possible to estimate very small quantities of chlorine, providing the quantity of salt in the fluid used for comparison be known. But on account of the difficulties in the way of weighing, measuring, and dropping, nothing but an approximation can be expected from the process. We think that by careful working the approximation may be made to exceed half a grain.

AMMONIA.

A minute and variable quantity of ammonia exists in the atmosphere. From this source rain-water receives it, which contains less than 0·5 part per million. The earth, in turn, absorbs it from rain-water, while some of it is destroyed by oxidation, so that rivers seldom contain more than 0·1 part per million, and perfectly pure spring or well water contains only a mere trace.

The ammonia process in water analysis is an indirect method of measuring the amount of organic matter which a water contains. Of course all the ammonia, as such, that any natural water might ever contain, is perfectly harmless. The decay of organic matter produces ammonia, and importance is attached to the latter only as it indicates the existence of the former.

In the laboratory two kinds of ammonia are recognized, "free" and "albuminoid." Free ammonia is that which has resulted naturally from the decay of organic matter contained in the water, and, other things being equal, shows how extensively such decomposition is going on. It is easily collected by distillation.

Albuminoid ammonia is that which results from hastening decomposition artificially. It measures the amount of organic matter present which may decay, and is simply what would be produced naturally in the course of time.

The ammonia process, when fully carried out, is the most reliable method known for determining the organic condition of water. To arrive at a correct conclusion in every case, it is necessary to estimate accurately both kinds of ammonia. The determination of albuminoid ammonia requires special apparatus, and is too complicated for general application; but the test for free ammonia is quite easily made, and from a series of experiments and observations it has been found that, generally, whenever a certain amount of free ammonia occurs in well-water, an excess of albuminoid ammonia is also sure to exist. So it is pretty safe to conclude that such water is polluted. Says an authority, "When the free ammonia exceeds 0·08 part per million, it almost invariably proceeds from the fermentation of urea into carbonate of ammonia, and is a sign that the water in question consists of diluted urine in a very recent condition. In these instances the water will likewise be found to be loaded with chlorides." Our experience places the amount a little higher than 0·08. We believe if a water contains 0·1 part per million of free ammonia, it should be regarded organically impure, especially if other indications point the same way. Of course there are exceptions. Some waters, organically pure, naturally contain much free ammonia, while others, that are badly polluted with vegetable matter, may contain sometimes much less than 0·1 part per million. In such cases the determination of albuminoid ammonia is indispensable to the detection of pollution. It is to be regretted that there is no simple and reliable method for doing this. But the cases are rare where water polluted with vegetable matter contains less than 0·1 part of free ammonia per million.

THE DETECTION OF AMMONIA.

The following process for detecting and estimating free ammonia is sufficiently simply and accurate for general application:

Dissolve some mercuric chloride (corrosive sublimate, a poison) in a little water, making the solution quite strong. Also prepare a strong solution of carbonate of soda (common cooking soda will do) by dissolving it in water. Place a tumbler of clear glass on a black surface in good light; fill it with the water to be tested, and then add a single drop of the solution of mercuric chloride, followed by a drop of the soda solution in the same place. Let the liquid stand without stirring. Look down through it, and if ammonia is present, even a minute quantity, a white cloud or opalescence, resembling white smoke, will be observed toward the bottom of the glass where the drops passed, which in the course of some hours will settle and cover the whole or part of the bottom of the glass with a white coating. If much ammonia is present, the reaction will be very marked, and almost instantaneous. Less ammonia requires more time, and the reaction is less marked.

The delicacy of the test is sufficient to give within five minutes a distinct reaction in water containing $\frac{1}{10000000}$ part of its weight of ammonia. Any one can satisfy himself of the delicacy of the test by the following: Add a spoonful of water free from ammonia (water that has been boiled for some time) a single drop of ordinary ammonia; then add a drop of this to a tumbler of water that has been well boiled, and apply the test in the manner described above.

If water shows the reaction, it is far from the sanitary standard for purity, which, as has been said, is not more than 0·1 part per million, and this number is ten times less than $\frac{1}{10000000}$, the limit of the test. Consequently, a water may contain too much ammonia and not show the reaction. To obviate this difficulty, a simple process of distillation must be employed.

If all the ammonia that ten volumes of water contain could be collected in one volume of water, and the test applied to this and a reaction occur, it is evident that the water in question contains at least 0·1 part per million. To effect the distillation, add two and a half quarts of water to a tea-kettle, and less if this quantity should come above the spout; then wrap one or two towels around a perfectly clean milk-can, covering the sides and bottom well. The can may be of any size, one that will hold two quarts is convenient. If a can is not to be had, a fruit jar, or a large pitcher, will answer the purpose. Support the can in a nearly horizontal position so the spout of the kettle shall be in the mouth of it. Keep the towels wet by pouring cold water upon them constantly after the water begins to boil. A basin should be placed beneath to catch the water as it runs from the towels. The steam, together with the ammonia, will be condensed in the can. When a half pint, or a tenth, of the water has come over, the operation should be stopped, and the condensed water tested, as described above. If no reaction occurs within five minutes the water is sufficiently free from ammonia. If a milk-can is used for a condenser, it should be most thoroughly cleaned, otherwise the condensed water will have a milky appearance, which will greatly interfere with seeing the reaction.

NITRATES AND NITRITES.

The presence of these salts is a bad indication only so far as they have resulted from the oxidation of nitrogenous organic matter. Nitrates contain more oxygen than nitrites, and have required more time for their formation. Their occurrence, taken alone, teaches nothing positive; taken in connection with other evidence, it gives valuable information. But as a rule, the presence of more than a trace of either salt is a strong indication of pollution from animal matter. However, some pure waters contain nitrates which they have dissolved from the earth and rocks of the locality. On the other hand, some very bad waters, especially those contaminated with vegetable matter, do not contain a trace.

A little nitric acid exists in the atmosphere, coming probably from the oxidation of ammonia. Hence rain-water contains it, and surface-water receives an additional supply from the oxidation of nitrogenous matter on the ground. It is then absorbed largely by the rootlets of plants. Hence shallow wells may receive it from surface-water. Other things being equal, they would naturally contain more of it when vegetation does not flourish.

The importance that is to be attached to distinguishing whether the nitrogen compound is a nitrate or nitrite, is this generally: If nitrites occur, it would seem to show that the pollution is recent, or its source very near. If nitrates alone exist, it would be inferred that there has been time enough for complete oxidation, and hence the pollution is of longer standing, or its source far away. It sometimes happens that the occurrence of nitrates indicates the approach of pollution instead of showing actual or past pollution. This is especially the case when there is no other evidence of impurity, unless it is that of chlorine, for the soil about a well acts as a filter to retain deleterious matter, letting pass through it only the ultimate products of decomposition, which are in themselves harmless, until it becomes so saturated with filth that it can no longer accomplish this.

NITRATES AND NITRITES DETECTED.

The following method for detecting nitrates and nitrites is delicate and easily applied:

Melt some zinc in a ladle, or iron spoon: stand in a chair and pour the melted metal in a fine stream into a pail of water standing on the floor. This granulates the zinc so it presents the greatest extent of bright surface. Prepare a little thin starch paste in the ordinary manner, dissolve a few grains of iodide of potash in water, and mix it thoroughly with the paste. Have at hand a little sulphuric acid.

To test for nitrites, add half a teaspoonful of the iodide of starch solution to a tumbler of water, and allow to mix. Then add a single drop of sulphuric acid. If any more than a trace of nitrous acid is present, a distinct blue color will result almost immediately. The test is so delicate that it gives, within a few seconds, a distinct reaction in water containing only the one hundred thousandth part of its weight of nitrous acid. And within a few minutes it will reveal less than one millionth part of it. If the color does not appear at the end of a few minutes, it may be decided that no nitrous acid resulting from filth is present. After standing several hours, the liquid usually assumes a blue color from the infinitesimal amount of the acid that may naturally exist in the water.

If no nitrous acid, or but very little is present, test for nitric acid as follows: Pour a pint of the water into a small nappy, add a spoonful of granulated zinc, and boil until about half of the water it driven off. This process reduces the nitric acid to nitrous acid. Let it cool and settle. Carefully pour off the clear liquid, and test by the method given above. If nitrous acid has been found previously, it will be necessary to notice whether the reaction in this case is more prompt and marked. It is well to have two glasses in readiness at the same time, one containing the water as it came from the well, the other that which has been boiled with zinc; add a little of the iodide of starch solution, and then a drop of sulphuric acid to each, as nearly at the same time as possible, and notice whether the reaction occurs in one sooner than in the other, as well as whether the color varies in intensity. If much nitrous acid occurs, it will be impossible to detect nitric acid by this process. When this is the case, the detection of nitric acid is not important. If a quite prompt and marked reaction for either nitrous or nitric acid takes place, the quantity is sufficient to render the water suspicious, and their presence forms a very valuable confirmatory indication of pollution in cases where a doubtful quantity of chlorine or ammonia occurs.

Any one desiring to do so, can easily perform interesting and instructive experiments by operating on water in which a little nitrate of potash (salpeter) has been dissolved.

LEAD AND IRON.

It is of the utmost importance to know whether water used for drinking purposes contains lead. A little gradually taken into the system does not pass off, but accumulates until the quantity is sufficient to result in bad, if not fatal, consequences. Since the poison is so insidious in its action, one does not receive warning until it is too late.

If a piece of bright lead is exposed to moist air, it soon becomes tarnished from the formation of a thin film of protoxide of lead, produced by the action of atmospheric oxygen. If this piece of lead should be now placed in water perfectly pure and free from air, the oxide would dissolve, leaving the metal bright, after which there would be no further action, since no more oxide could form. But if air had access to the water, the twofold action of oxidation and solution would continue together, and the surface of the metal would remain more or less bright, according as the oxide is formed faster or slower than it can dissolve. If some sulphate or carbonate be now added to the water, these salts immediately react with the oxide to form on the metal an insoluble coating of carbonate or sulphate of lead, which, being insoluble in water, prevents further action. These facts explain the behavior of natural waters toward lead. In the first place the protoxide of lead is always formed, which dissolves if the water does not contain the necessary saline constituents to prevent it. Water that contains any salt of lime or magnesia in excess is called hard water. Generally these bases are present in the form of carbonates or sulphates: hence the commonly accepted view that hard water does not act on lead. But here is an error that must be guarded against. The water fails to act on lead, not because it is hard, but because it contains sulphates or carbonates. A soft water, containing sulphates or carbonates of the alkalies, has no action on lead. On the other hand, a water hard from the presence of carbonate of lime or magnesia frequently acts on lead freely, because the same acid that dissolves them and explains their presence, also dissolves carbonate of lead. Hence it is plain that some very hard waters, highly charged with carbonic acid, readily act on lead. The decomposition of organic matter produces carbonic acid; consequently the presence of organic matter facilitates the action of water on lead. Nitrates dissolve lead freely. The metal should not be used in waters containing them. Sulphates in water protect lead most, since the sulphate of lead is insoluble in water and acids. Carbonates are next in order. The carbonate of lead is insoluble in water, but soluble in acids, even the weak carbonic acid.

Water that is hard is so, generally, from the presence of sulphates or carbonates of lime and magnesia, so that ordinarily it might be considered safe to use lead in hard water. But since there are exceptions both against hard water and in favor of soft water, the only safe way is to test every water in which lead is used.

Hard water is readily known from its behavior with soap. In such water considerable soap is required to produce a foam, and quite a quantity of white or gray flakes will appear on the surface of the water. This substance is really lime, or magnesia soap, these bases having taken the place of the soda and the potash which the soap contained. When the hands are washed in hard water, unless enough soap is used to make a good foam, it is impossible to give them a clean feeling. The hardness of water may be an indication that it does not act on lead.

Another rough method is, to observe whether the surface of lead which has been in water for some time is bright and shining, like newly cut metal, or is dull in color, very gray, or brownish. Too much reliance should not be placed upon the color, for the oxide may not dissolve fast enough to keep the metal bright, and yet not much may dissolve. However, if the surface is bright and clean, the evidence is decisive; for it would not be so if the oxide did not dissolve.

THE TEST FOR LEAD.

Prepare a solution of sulphide of soda as follows: Thoroughly mix a small quantity of sulphur (about a teaspoonful) with twice its quantity of cooking soda; put the mixture in an iron spoon, or ladle, and heat it over the coals until it is well melted and the flame of the sulphur has gone out. Scrape the black residue from the spoon, and add to it in a small bottle an ounce of water. Let the solution stand for several hours until the insoluble parts have settled, then pour off the clear, yellowish green liquid into another bottle. Have at hand a little hydrochloric acid (muriatic acid). Fill a tumbler of clear glass with the water to be tested; place it on a white surface in good light; add one drop of the sulphide of soda solution, stir the liquid, and if lead is present it will assume a brownish black color, the depth of color depending on the amount of lead. To ascertain whether the color is due to lead and not to iron (for the sulphide of iron is also black), add to the solution a single drop of hydrochloric acid, and stir it. Do not add the acid until after the sulphide has been added. If the color disappears, it is due to iron; if it grows paler, but does not disappear wholly, it is partly due to iron and partly to lead; and if the color does not change, lead is the cause of it. After the acid is added the liquid is apt to assume a slightly milky appearance from the separation of sulphur. Care must be exercised not to confuse this with an actual fading of the color.

Good water should contain less than one-tenth grain of lead per gallon. The test gives a distinct reaction with less than this amount. But the exact quantity cannot be determined outside of the laboratory. Unless one is so particular to know the amount as to have the work done, it is best to

reject a water that gives any coloration with the test, since it is safer to drink no lead at all.

IRON.

It is not often that a water is found which contains enough iron to be prejudicial to health. Some authorities say that there ought not to be more than two-tenths grain per gallon, and others think that water containing one-half grain per gallon is not injurious.

Iron is detected by means of sulphide of soda and hydrochloric acid. If no lead is present, the color produced by the sulphide must dissolve completely on the addition of two or three drops of acid.

If it be desirable to learn whether there is more than half a grain of iron in a gallon of any water, dissolve one ounce avoirdupois of sulphate of iron (copperas) in eleven ounces of water. Each drop of this solution contains about one-sixty-fourth grain of iron. Add one drop of the solution to four ounces of pure water, which will then contain iron at the rate of about one-half grain per gallon. Add to this a drop of sulphide of soda, and compare the color with that of the water in question.

THE PERMANGANATE OF POTASH.—TEST FOR ORGANIC MATTER.

The union of oxygen with dead organic matter always occurs when the two are brought together under favorable circumstances, and the disappearance of the one may be made to reveal the presence of the other.

The solution of permanganate of potash has an intensely deep purple color, which is owing to the oxygen it contains. Whenever this solution is brought in contact with easily oxidizable substances, it loses its oxygen and consequently its color. If, therefore, enough of the solution be added to a suspected water to impart a distinct tint, and the color disappears, it is certain that something is present which is capable of taking the oxygen from the permanganate. Whether this is organic matter, or something else, is uncertain without the application of other tests. The only other substances which are apt to occur in a water, and are capable of effecting the change, are ferrous salts, nitrites, and hydrogen sulphide. If these are known to be absent, and the color of the permanganate disappears, it may be decided that organic matter is present. But if either of these occurs, the test has no value.

The methods for detecting nitrites and iron, which is most always, when present, in the form of a ferrous salt, have been given. Sometimes, however, iron occurs in water as a ferric salt. This does not affect the permanganate; but the method given for detecting iron makes no distinction between its two classes of salts. To distinguish them is too difficult, except for the chemist.

To detect hydrogen sulphide, shake some of the water in a clean bottle, and observe the odor, which is the same as that emitted by the solution of sulphide of soda.

It is another drawback to the permanganate test that it does not act on albuminous substances, urea, kreatin, sugar, gelatine, or fatty matters. So that a water might be very badly polluted and yet give no indication of it with this test. Cases are recorded where sickness resulted from the use of water supposed to be good because it did not affect the permanganate. Other instances are recorded where good water was condemned from the application of this test. From what has been said, it will be seen that this test alone is reliable only when iron, nitrites, and hydrogen sulphide are known to be absent, and at the same time the color of the solution disappears. It is often valuable as a confirmatory test, and for that purpose it is described here.

The solution is easily prepared by dissolving the crystals of permanganate of potash in pure water. To apply the test, take two tumblers of clear glass; fill one with water of known purity, and the other with the water to be tested; then add a drop of the solution to each, and compare the change in color. Those who have been accustomed to work by this method are guided by the following rules: If decomposing organic matter be present in a degree hurtful to health, the pink color is changed to dull yellow; or, if a still larger quantity exists in the water, the color will in time entirely disappear. Where the color is rendered paler, but still retains a decided reddish tinge, then, although putrefying organic matter is present, it is so in such minute quantities as are not likely to be immediately hurtful. The quicker and more perfect the decoloration of the water tested, the greater is the quantity of decomposing organic matter.

The following preparation of permanganate is a more delicate and perhaps a more reliable test than the simple solution:

Caustic potash	4 parts by weight.
Permanganate of potash	1 part "
Distilled water	160 parts "

If it is found inconvenient to weigh the very deliquescent caustic potash, the liquor potassæ of commerce may be substituted. Then the formula is:

Liq. potassæ	70 parts.
Distilled water	90 "
Permanganate of potash	1 part.

If the solution is kept in a glass-stoppered bottle in a dark place, it will remain good for a year or more. This test is applied in the same manner as the simple solution. It is claimed that water of average good quality, with this test, will keep its color well for forty-eight hours. If it becomes decidedly paler in twenty-four hours, it is hardly fit to use. Those who employ the method do not claim for it scientific accuracy, but think, in the absence of opportunity for a more careful analysis, a ready and reliable conclusion may be reached. We think the claim for reliability is too strong on account of the same reasons that were given under the description of the simple solution.

It would be interesting and profitable for any one purposing to use the permanganate test in either form to collect samples of water from several sources—wells, springs, brooks, and stagnant pools—and to apply the test to them, comparing the results. It would be well to do the following also: Add a little sulphate of iron to water distinctly colored with permanganate. The color will quickly disappear. Repeat the experiment, using nitrite of potash, having prepared some by boiling a solution of saltpeter with zinc. The effect of hydrogen sulphide may be seen by doing the experiment with sulphide of soda.

INTERPRETATION OF RESULTS.

Nearly enough has been said under the several divisions to direct one to fair conclusions. It must not be inferred that the methods presented here are infallible guides to the quality of a water. All that can be claimed for them is, that in most cases they will reveal the character of waters which are so polluted as to be immediately injurious to health. Some, that are polluted with vegetable matter alone, may escape detection. Other tests, which cannot be used by people generally, must be made before all that can be known of a water will be revealed.

It is seldom that a bad water will show all the indications that have been described. If an excess of both chlorine and ammonia occurs, the water is polluted with animal matter or with drains. If considerable chlorine is present, together with a strong reaction for nitrates or nitrites, while ammonia is not found by means of the test described, a past or future pollution is indicated. If an excess of ammonia alone occurs, contamination from vegetable matter is suggested, which becomes quite certain if the sugar test and the permanganate of potash have given a reaction.

But there are more conditions and variations than can be specified for every case. The application of the tests, and an examination of the surroundings of a well, together with thought and judgment, will usually lead to the right conclusion.

THE ART OF SWIMMING.

NATATION is locomotion in water. To go, to come, to evolute in water, is a gift of nature to some animals. Does man enjoy the same privilege? It has been said so, but observation does not confirm the assertion. In truth, certain populations, certain individuals, exhibit exceptional arrangements for natation. But this is due either to personal

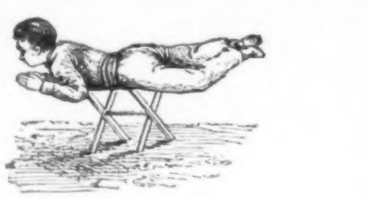


FIG. 1.

aptitude or else to the influences of race, heredity, or surroundings. Upon the banks of large rivers and upon the sea coast it is rare to find any one who is not a good swimmer. In this respect the reputation of the inhabitants of Delos is classic. On their side, the islanders of Oceanica in no wise cede to the ancients. Captain Cook remarks that the agility, skill, and ease of the inhabitants of Tahiti in swimming astonished him. Neither the violence of the surges nor the height of the waves daunted them, and, where our best swimmers would have met their death, these individuals experienced pleasure. To ask a New Caledonian whether he knows how to swim is, according to Mr. De Rochas, to ask him as curious a question as whether he knows how to walk or run.

In spite of all, there exists between the mechanism displayed by the animal and that which man is obliged to have recourse to in order to swim a fundamental difference. The vertical attitude is proper to man, and he must renounce this in order to assume one that is in opposition to his instincts. In the water, on the contrary, the animal preserves

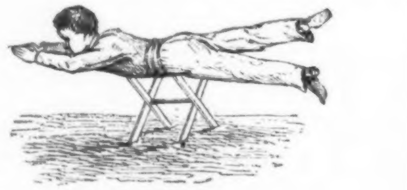


FIG. 2.

the attitude which is natural to him, and, properly speaking, he continues his walk.

Let us add that even in the midst of maritime populations, whose arrangements for swimming are so happy, the child in order to become a swimmer needs, as everywhere else, to be exercised.

Swimming has to be learned; it is an art. By the obligations that they imposed upon youths, the legislators of antiquity showed the great value which they attached to its culture. At Lemnos marriage was forbidden to all who were unable to dive to a depth of 8 fathoms. In Macedonia, at Lacedemonia, the women rivaled the men in boldness and skill in swimming. To-day in a large number of countries the art of swimming figures in the programmes of teaching. It has been inscribed in those of the French lyceums since 1868.

The methodical teaching of natation comprises two orders of exercises: (1) the elementary motions out of water; and (2) the evolutions in water. The importance of the first of these has struck all those who have seriously occupied themselves with the question. It is the correct execution of them that gives ease and confidence in the water. In order to accustom pupils to regular developments of the legs and arms, Clias suspended them from a pulley by means of a cord hooked to a wide girdle that surrounded the trunk, and in this position he demonstrated to them the theory of the motions.

The editors of the "Manual of Gymnastics," published under the auspices of the Ministers of Public Instruction, advise that the pupil, after being broken in to partial motions, shall be made to lie flat on his belly upon a wooden horse. In this posture, similar to that which is assumed in water, he is thoroughly familiarized with the mode of locomotion which he would have recourse to in order to sustain and direct himself if he were actually swimming. The theory of the motions in general is as follows:

At the order, "On horse, in position!" the body is placed in sufficiently stable equilibrium to allow the legs and arms to act (Fig. 1).

At the order, "One!" the arms and legs are quickly elongated, and the latter separated.

At the order, "Two!" the knees are brought together, the legs stretched out, and the hands separated 16 centimeters (Fig. 3). At the third order a semicircle is described with each hand, and the heels are brought near to the body (Fig. 4).

It would be impossible to dwell too long upon the utility of these preparatory exercises.

Yet the use of the wooden horse, and that of the cord and pulley, is open to criticism. The total weight of the body rests upon the anterior face of the trunk, and the upper and

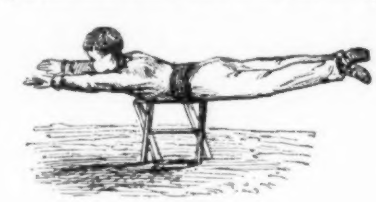


FIG. 3.

lower limbs are in space, and are obliged to sustain themselves in a horizontal position by their own strength, without a bearing point. The result is, in the first place, great fatigue to the limbs that are to be broken in to a series of co-ordinated and rhythmical motions, and, in the second place interference with the respiration, due to a compression of the thoracic regions by the weight of the body.

An apparatus due to the inventive genius of Messrs. Petit and Dumoutier seems to be arranged in such a way as to overcome this double inconvenience, and to permit of exercising out of water without fear of fatigue and oppression. This apparatus (Fig. 5) consists of a strong plank that receives a support for the body, and two for the arms and two for the legs. The support for the body is so arranged as to allow free play to the respiration, thanks to two cushions, one of which sustains the upper part of the chest and the other the belly. The fore-arms rest upon two pivoted uprights that allow the arms to describe an entire circle. The legs rest upon two other uprights that are doubly jointed, that support the anterior face of the thighs and legs, and that not only allow these organs to execute the three phases

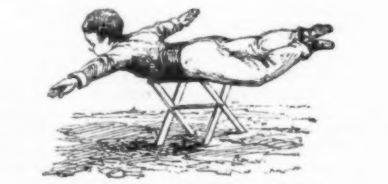


FIG. 4.

of the motion assigned to them, but also cause these phases to be executed in an absolutely correct manner. In this way the pupil performs his evolutions without any sort of constraint. His body rests upon eight bearing points. The apparatus is made of forged iron, is very strong, and is fixed to the base board through a system of copper tubes that permit of the limb supports being brought closer together or separated farther apart according to the pupil's stature.

In the starting position, the heels being brought near the body, a strong inspiration is taken, and the lungs are filled with air. At the order "One!" the arms are elongated, and the legs thrown outward and stretched as far apart as possible. At the order "Two!" the elongated legs are quickly brought together, and the air is expelled through the nostrils. At the order "Three!" the pupil returns to the starting point. His hands turn over and describe a large circle, his legs bend over upon the separated thighs, and his heels rise without leaving each other. He now fills his lungs with air. This theory of the motions of natation has the advantage of calling attention to the manner of breathing methodically in the water and of accustoming the pupil to

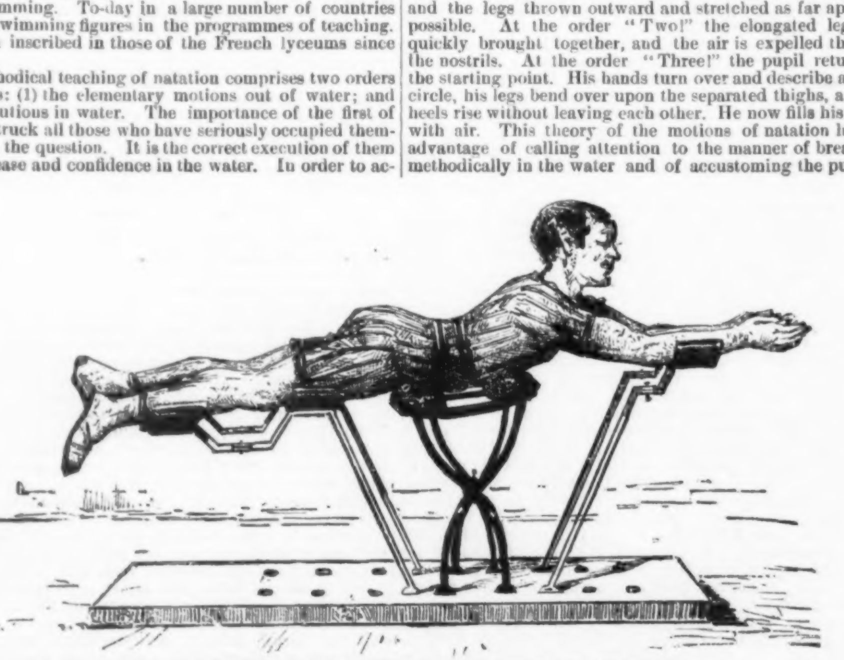


FIG. 5.—PETIT & DUMOUTIER'S SWIMMING APPARATUS.

it. Now this is a point of capital importance. To know how to control the motions of respiration, and consequently to prevent strangling, is to be acquainted with half the art of swimming.

The intuition of the dangers to be run, which is awakened every time a man is thrown into a strange medium, never perhaps solicits his instincts of self-preservation more forcibly than when he suddenly falls into the river. If he totally ignores the art of sustaining himself upon the water, he shouts "Help!" loses his head, struggles, and sinks. If he has some accurate notions about swimming, all his forces tend toward one end—the shore—and the superabundance of the energy that he displays, depriving him of a portion of his advantages, reduces his chances of safety by one-half. If he is a skillful swimmer, he preserves his coolness, divides his efforts, and, reaching shore without trouble, laughs at the incident. But man does not become a swimmer except by force of practice. History furnishes numerous examples of what it may be possible for him to do, and the locomotive power that he may acquire by repeated and persevering exercise. According to Herodotus, a Macedonian swam about a kilometer and a half (nearly a mile) to carry the news of the shipwreck of a fleet. As soon as the bridge that he was defending was cut, Horatius Cocles jumped all armed into the Tiber, and owed his preservation to his skill as a swimmer. Sertorius, while wounded, traversed the Rhone in the same equipment. Old and worn out with fatigue, Marius was enabled to escape the pursuit of Sylla's emissaries by swimming to two ships that had been seen from the coast. At the siege of Alexandria, Cæsar saved himself, thanks to the same expedient, and, at the same time, held his tablets in his left hand out of the water. On May 5, 1810, Lord Byron successfully swam across the Hellespont, as Leander is said to have done before him. The distance from shore to shore must have then been 1,255 meters (4,116 feet). In 1818, at Venice, Lord Byron raced for four hours and a half, and left far behind him Chevalier Mengaldo, who had boasted that he was the stronger swimmer. Some years ago an Englishman swam across the Channel from Dover to Calais.

There is one complement to natation that is of the highest importance, the habitude of swimming all dressed. In order to contract such a habit, the simplest and most rational method is at first to keep on the pantaloons, then the pantaloons and waistcoat, and then all the clothing. In case of accident, one will then be sure of preserving his wits. But it is from a military standpoint especially that this is of importance, and men of war have from all times been struck with it.

According to Silius Italicus, Scipio Africanus traversed rivers by swimming with his cuirass on his back, and at the head of his legions. Under the direction of Colonel Pfuhl, the troops were exercised in maneuvering by swimming in uniform and in arms at Berlin in 1815. In 1818 the soldiers of the Danish army were likewise exercised in swimming, all dressed, equipped, armed, and each carrying a man on his back. Finally, Garcilaso de Vega, in his History of the Conquest of Florida, tells the following touching story: Pursued by the Spaniards, the Indians jumped into a lake and continued the fight until nightfall. They were seen swimming four abreast, close together, and carrying a comrade upon their backs who continued shooting until the projectiles were exhausted. The next day, exhausted by fatigue, the majority of these brave Indians surrendered; but there remained seven more intractable than the others, who staid in the water, defying the conquerors upon the shore and crying that they might be forced to perish through exhaustion, but not to surrender. They swam in this way for thirty hours without taking any food, and it became necessary to bring them on shore by force, by going into the water and dragging some of them out by the legs and some by the arms. There is no need of longer dwelling upon this subject to show the importance of the art of swimming, and the degree of perfection that man is capable of attaining, as well as the interest that attaches to the rational direction of the *debuts* in this art.

We shall now consider how, by the aid of that device, the motions or operations that permit of swimming are effected. Let A be a swimmer, and let us suppose him for an instant immovable in the air or water, and in an initial position ready to start. It is from this position that he will pass, through a preliminary motion having *progression* for its object, to the position, A'. This first motion comprises, along with a strong inspiration of air, a simultaneous elongation of the arms and legs—the latter separating as shown in Fig. A'. The second motion, which is effected in expiring air through the mouth or nostrils, consists in passing to the position, A'', by opening the extended arms, with palms inclined outwardly, to a position parallel with the body, and, at the same time, extending the legs and bringing them together. From this second position, a passage is made to the following, A''', by continuing the motion of the arms to a position of right angles with respect to the body—the legs being slightly bent without allowing the heels to separate. This third position, which is reached at the end of the expiration of air, may be considered as a return to the initial position, A, which the swimmer reaches by bringing his arms toward the axis in order to join it (Fig. A), without modifying the position of his legs. He now breathes, and then, from the final-initial position, A''' A, passes anew to the position, A', and then, in expelling the air from his lungs, to position, A'', and so on. The result for the beginner is that he succeeds in sustaining himself in the water, and in progressing. After this he will learn to make his motions regularly and gracefully, and, confident of his success, he will regulate his respiration, whose two pulsations of inspiration and expiration must be accomplished at an equal distance apart in the total evolution of the motions. A breath should be taken at each complete evolution.—*Science et Nature.*

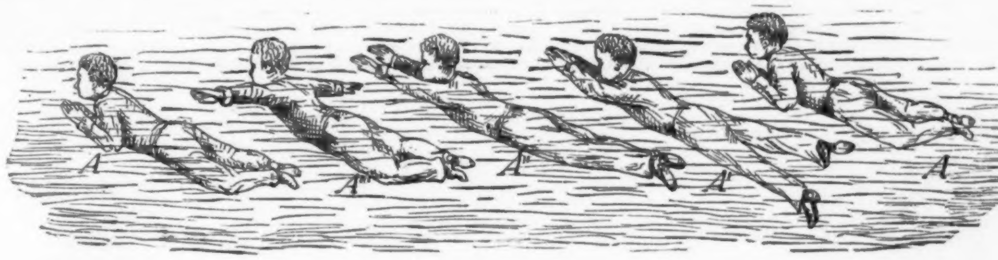


FIG. 6.

SCOTCH WILD CATTLE.

IN some of the parks of England and Scotland herds of white half-wild cattle are kept, which are generally known as "wild cattle," and are direct descendants of the long-maned white cattle that formerly inhabited the Caledonian woods. At the end of the last century these fine animals were still kept in the parks of Chillingham in Northumberland, Wollaton in Nottinghamshire, Gisburne in Yorkshire, Lime Hall in Cheshire, and Chartley in Staffordshire. The oldest stock is at Hamilton, but in 1760 most of the animals had to be killed on account of viciousness. Since then, however, great care has been taken in their breeding, and at present Chillingham Park has the finest herd of these animals. Another fine herd is at Hamilton, near Glasgow.

Near Hamilton, on the banks of the Avon, the ruins of the old Cadzew Castle are located, which was destroyed during the reign of the unfortunate Mary. In the beautiful park surrounding these ruins hundreds of enormous oaks grow, which are the last remnants of the Caledonian woods, and are preserved with the greatest care possible. The animals are kept in this park. They are never stabled, the cows are never milked, and when the number of animals increases too rapidly they are shot by hunters in the same manner as deer and other game.

The animals are of a clear white color, the neck and tail tassel are yellowish, the nose, eyes, ears, and hoofs are jet black, and the legs from the knees downward are spotted. On some animals the ears are russet red. The horns are very slender, and are whitish with black tips. They are of medium length. The steers are very large and strong, and have long, curly, shaggy hair, forming a mane.

The annexed cut, which is taken from the *Illustrirte Zeitung*, represents a steer, a cow, a heifer, and a calf. The drawing was made by the well known artist, Ludwig Beckmann.

A GROUP OF WILD SCOTCH WHITE CATTLE.

[THE GARDEN.]

THE WHITE BIRCH AND ITS VARIETIES.

THE genus Betula contains about five-and-twenty species, and is most numerously represented in the northern hemisphere, where it ranges from temperate to arctic regions; it is also found in Mexico and Peru. None of the species, if we except the second British one, the dwarf mountain birch (Betula nana), has a geographical range so extended as B. alba, the subject of these notes; moreover, not one is such a handsome and graceful tree. Either when in leaf or leafless it possesses an airy grace all its own. Few will be disposed to question the judgment of the poet Coleridge, who pronounced it—

Most beautiful
Of forest trees, the Lady of the Woods.

It is no less remarkable for its lightness and elegance than for its hardiness. It stands in no need of protection from other trees in any stage of its growth, and lives on the bleak mountain-side and other exposed situations from which the sturdy oak shrinks in dismay. Putting on one side the only other representative of the genus Betula in Britain (B. nana), some of the Alpine willows, and the dwarf juniper, none of which can be called trees, no other native tree ascends to such elevations in Britain. In the Highlands of Scotland it is found at heights of 2 500 feet above the sea level, while the common juniper only reaches to 2,400 feet, the Scotch fir to 2,200 feet, the alder to 1,600 feet, and the oak to 1,350 feet. The higher, however, the tree ascends and the more northern the latitude, the more shrub-like does it become. It is a fast-growing and rather short-lived tree, in favorable localities sometimes attaining a height of eighty feet, though generally not exceeding thirty feet or forty feet. In very bleak, exposed situations or at considerable elevations it often grows no higher than two feet or three feet. To the inhabitants of northern latitudes it is of no little importance, and an interesting series of objects in the museum (No. 1) at Kew prove to how many purposes its wood and bark are applied. Perhaps it will be hardly out of place to mention a few of these here. Bread of birch bark from Lapland, made as long ago as 1857, shows one of the very many uses to which birch bark is or may be put. Shoes made of strips of bark, used by the peasants of Northern Sweden when at work in their distant meadow swamps, neat baskets in which they sell wild raspberries; and a specimen of the well-known Alp horn from Switzerland, by no means exhaust the enumeration of articles illustrating birch bark at Kew. It is a valuable tanning agent, and an oil expressed from it is largely used in the preparation of Russian leather; indeed, it is to this oil that the peculiar fragrance of that article is due. Formerly the Highlanders used the outer layers for lighting purposes, and, before the invention of paper, the inner ones for writing upon. The sap is convertible into wine, vinegar, and spirit; when fresh it forms an agreeable beverage, and an intoxicating liquor when fermented. The wood is esteemed for light turnery work, and is at the present time largely employed in the manufacture of spools or cotton reels. By many authorities what is here looked upon as a single species is divided into three, viz.: B. verrucosa, B. pubescens, and B. virgulosa (B. urticæfolia). The latter only occurs as a cultivated plant in Britain, but it seems to be simply a form of B. alba. The distinctions relied on by authors to distinguish the two first named forms reside principally in the leaves and the fruiting bracts.

In B. verrucosa the leaves are said to be more or less truncate at the base, and the lateral lobes of the bracts in the female catkins are falcate-reflexed or spreading; the fruit, too, is said to be obovate. In B. pubescens, on the other hand, the leaves are described as being more or less rhomboid, and the lateral lobes of the bracts of the female catkins are ascending, the fruit being broadly obovate. After a careful examination of a large series of wild specimens, as well as the cultivated collection at Kew, I am convinced that these characters are not to be depended upon, as I have found repeatedly trees with well-marked foliage of the one so-called species and bracts and fruits agreeing perfectly in form with those of the other one. The pubescence, too, varies considerably, as also does the form of the fruit. Leaves, glabrous or pubescent, occur in conjunction with the two forms of bract and fruit. Altogether, so many intermediates occur in some of the wild birch forests which cannot properly be referred to either B. verrucosa or B. pubescens, that the only course is to group the whole under the Linnæan B. alba. As it would occupy too much space to mention all the names which have been given to so-called species split off B. alba, and as the books in which they are described are inaccessible to the great majority of my readers, it will be enough to say here that I include under B. alba all the arboreal birches of Europe and the poplar-leaved birch (B. populifolia) of North America. Most of the varieties which follow are probably of garden origin; where such is not the case, and it is known to me, I mention it. The birch grows freely in almost any soil; in a wild state it is frequently found in a poor, shallow, sandy loam, where scarcely any other tree would flourish. The garden varieties, as well as those which have originated in a state of nature, must be increased by working on the common white birch.

Var. dalecarlica.—This was first found wild in the Swedish province which suggested its name, and was described as a species by the younger Linnæus. As far as foliage is concerned, it is by far the most distinct of all the numerous varieties of B. alba. The leaves are very deeply cut—indeed, almost palmate; and the segments toothed—Bosc says, "cut like those of hemp." The twigs are slender and pendulous. It is a charming decorative tree, well worth a place in every collection of deciduous trees. In some nurseries it is met with under the names of Incisa, laciniata, and laciniata pendula.

Var. fastigiata is one of the most striking varieties in cultivation. It was sent out by an Alsatian nurseryman less than a score of years ago, and is now getting fairly well known. It exactly resembles the Lombardy poplar in habit, and has dark green leaves, which are retained longer on the tree than those of any other variety of the white birch. For some years at Kew the foliage of this variety has remained unchanged some time after that of its neighbors have been shed. Frequently, both in books and gardens, it is met with under the name of B. pyramidalis.

Var. foliis argenteo-variegatis, var. foliis aureo-variegatis.—The names of these are sufficiently indicative of their character. Except in general collections and in large places, or by those specially interested in variegated trees, are they at all likely to be grown.

Var. foliis purpureis is a variety of erect habit, and where it does well is a very ornamental tree. In spring and early summer the leaves are a deep reddish-purple, and even in late autumn they exhibit a decided bronzy tint. It is known in some gardens as B. atro-purpurea and B. purpureo-nigra.

Var. pendula (the Weeping Birch).—This is too well known to need description. The ordinary form reproduces itself fairly true from seeds, but often does not put on its distinctive character until the trees have attained some little age. Sub-varieties of this form, which are usually grafted standard high on B. alba, are B. pendula elegans (*Woods and Forests*, vol. i., 458), a less graceful and more formal plant than the common weeping birch; in habit it quite resembles the Kilmarnock weeping willow. B. pendula Youngi is another very decided weeper sent out some years ago by Mr. Maurice Young, of Godalming.

THE WEEPING WHITE BIRCH.

TWIG OF BETULA ALBA, WITH CATKINS, FEMALE FLOWER AND FRUIT.

YOUNG TREE OF BETULA POPULIFOLIA.

Var. populifolia (the American White Birch) has triangular, very taper-pointed, long stalked leaves, larger in size than those of any European form of B. alba. It is a small and slender, graceful tree, rarely exceeding 20 feet to 30 feet in height. It is common on poor, dry, gravelly soils from Pennsylvania to Maine (near the coast), and is also found on the borders of swamps. According to Professor C. S. Sargent's "Catalogue of the Forest Trees of North America," it springs up everywhere on abandoned land in New England. The same authority describes the wood as white, moderately hard, close-grained, and susceptible of a good polish; it is extensively manufactured into spools, shoe-pegs, etc., and recently has been largely exported. Two sub-varieties of this occur in gardens—one, laciniata, with leaves more deeply cut than the type, and the other, pendula, with drooping branches like those of the weeping variety of our native birch.

Var. pubescens has hairy leaves, smaller in size than those of B. alba, with which in a wild state it may nearly always be found growing.

Var. virgulosa (*urticæfolia*) is said to be found wild in Southern Sweden. It has small, dark green, hairy leaves, irregularly and deeply toothed. It is a somewhat slow grower, and is a very distinct variety. B. heterophylla, a seedling which originated some years ago in the Isleworth Nurseries of Messrs. C. Lee & Son, is very similar in habit and in outline of leaf, etc.

GEORGE NICHOLSON.

Royal Gardens, Kew.

WINTER CULTURE OF MIGNONETTE.

MIGNONETTE is of easy cultivation when once its requirements are understood. Some potfuls are useful and acceptable for decoration at all times, but especially in the spring and early summer; it can then be obtained in greatest perfection. During hot weather mignonette has a tendency to produce seed so fast, that its beauty is soon lost. It is grown largely and well in the London market gardens, and it is but reasonable to suppose that equally good results should be obtained by winter cultivation away in the country where the atmosphere is much clearer. The earlier the seed is sown in September the better, as the plants then get tolerably strong and are better enabled to withstand the winter. It is best to sow in the pots in which the plants are intended to flower. These should be 5 inches or 6 inches in diameter, and be used clean and well drained. A good proportion of old mortar mixed with rather heavy loam and some dried cow manure I find to be an excellent compost. This can scarcely be rammed too hard in the pots if used somewhat dry, as the roots when once started will penetrate the hardest of soils. In filling the pots care must be taken that the whole of the soil forms one mass, for if it be rammed in separate layers, neither the roots nor water pass through it so freely. A little of the same soil should be sifted for covering the seed after it has been sown. The latter, if good, will only require sowing thinly, and the pots may be placed in any cold frame until the end of October. Abundance of air should be admitted after the plants appear, and these should be gradually thinned out to six or eight, according to the size of the pot. It is not advisable to thin too much in the autumn, as some of the plants are liable to die away in the winter. Those selected should be the strongest and most evenly placed over the surface. Mignonette is best kept through the winter in a cool place where all available light can be obtained and air admitted on favorable occasions. It should not be encouraged to grow in mid-winter, as it then becomes so weak, neither should it be exposed to dry fire heat. A position near the glass in a house where carnations, bouvardias, and such like plants flower in winter suits it admirably, as the circulation of air admitted by the laps of the glass prevents injury to the mignonette by the necessary fire heat in severe weather.

Frames, such as are used for bedding plants and where heat is only applied to expel damp and keep out frost, may also be employed, but as these have often to be covered up during a spell of frost, the house has a material advantage. Some advise keeping mignonette dry in winter, but I consider this quite a mistake. The plants do not require so much water at this season, but some should be given whenever necessary. If this is not done, in all probability they will die when it is given after allowing them to get quite dry. As the days lengthen in spring and the flowers show, plenty of water should be applied. A little artificial manure mixed at first with an equal portion of dry loam and spread with a label over the surface of the soil will prove beneficial, and the strength may be increased with safety as the plants progress. A small stick placed to each plant when young will keep them from falling about, and a much better shaped plant can be obtained than if it be tied later on. Batches to succeed these may be sown at intervals during the summer, and, with the exception of selecting a cool position, the same treatment may be adopted.

The best variety we have found for pot culture is a selected form of Miles' Spiral. It is not easy to obtain it true from seedsmen or to keep it true if other sorts are grown. The best plan is to weed out any plants that are not true so soon as the first flowers open, and save seed from the best and most vigorous growing forms; a select strain can thus be obtained even in one season, and it can only be kept true by growing the one variety and saving seed annually, from the spring flowering plants preferred. The true variety above mentioned is a vigorous grower with broad foliage, and the spikes attain a length of 9 inches or more under good cultivation. It would be a great advantage to private gardeners to save seed themselves of any good annual plant they may possess, and such as cannot be obtained true with certainty from other sources. Where numerous varieties have of necessity to be grown near each other for seed production, the inferior forms will seed most freely, and, worse still, the pollen from these becomes distributed to the better ones, and causes their deterioration. Mignonette is a case in point. Let the above advice regarding it be put into practice, and the results will well repay the extra trouble incurred.—*J. G. K., in The Garden.*

COMETS.*

By Prof R. S BALL.

FOR several months past I have anxiously considered how I could best discharge the honorable duty which has been intrusted to me this evening. I have to deliver an astronomical discourse, and to do my very utmost to make that discourse adequate to the subject, adequate to this large and cultivated audience, and adequate to the memorable occasion on which the British Association has first crossed the Atlantic Ocean.

I propose to address you this evening on the subject of comets, but it will be readily understood that, of a subject so vast and so elaborate, only a slender proportion can be comprised within a single lecture. The first question to be decided was how to select from the vast mass of materials those which would be most suitable for our discussion this evening. To describe the natural history of comets with any approach to completeness would be a very tedious, indeed almost an endless, task. We must rather select those episodes in the history which have especially added to our knowledge and enabled us to obtain a rational view of the whole subject. Does not Longfellow tell us how impossible it would have been for him to portray the fortunes of Evangeline throughout every detail? He has only disclosed to use the picturesque and eventful phases of that history. May I be permitted to say that I desire to treat my subject in a similar manner, and while concentrating my attention on the really important matters I shall yet follow the wanderer's footsteps, "not through each devious path, each changeful year of existence."

In pursuance of this scheme I shall at a single blow lop off all the earlier parts of the history. The great primitive discoveries of the character of comets and of their movements must be entirely omitted. The splendid researches of Sir Isaac Newton, and the classical achievement of Halley, are among this class. They are no doubt familiar to every cultivated mind, for they belong to that wondrous alliance between mathematics and astronomy which imparts a thrill of pleasure to the generous intellect. They are not for our discussion to-night.

* Lecture by Prof. R. S. Ball, Astronomer Royal for Ireland, at the Montreal meeting of the British Association.

I shall only address you upon the more recent acquisitions to our knowledge of comets; and in order to give definiteness to our programme, I shall select a certain epoch not yet twenty years old, which is to bound our retrospect into time past. There is a special appropriateness in the choice of the year 1866 as a starting point for the modern history of comets. A very memorable occurrence in that year attracted universal attention, and threw much and quite unexpected light on the nature of comets. The review of the subject given in this lecture will extend from the year 1866 to the present time. But even in this restricted interval it will not be practicable for me to give anything like an exhaustive account of the different researches that have been made. Every astronomical journal teems with observations of comets. Every year brings us one, or two, or three, or more comets; organized efforts are made to observe these comets to the utmost, and each season has its own harvest of discoveries. Amid this host of claimants for our attention we must wend our way this evening, glancing at some discoveries, according to others such notice as their importance may merit, but reserving special attention for the three monumental achievements in the modern history of comets. These are, first the determination of the connection between comets and shooting stars; secondly, the spectroscopic researches on comets; and thirdly, the investigations of the tails of comets. The first of these subjects must be for ever associated with the name of Professor Schiaparelli, the second with the name of Dr. Huggins, the third with the name of Professor Bredichin.

It was long ago remarked by Kepler, in language of splendid exaggeration, that there were as many comets in the heavens as there were fishes in the ocean. There are comets large and comets small, comets with one tail, comets with two tails, and comets without any tail at all. Comets appear at uncertain and irregular intervals; they are not confined to any special part of the heavens. A comet may be first discovered in one constellation, and after a journey across the heavens it may sink to invisibility in any other constellation. A comet is sometimes only seen for days or for weeks, but sometimes it remains visible for months or even for years. The features of the comet itself are also in a course of incessant transformation during its visit. Its size and its shape are not constant. The interval of a few days, or sometimes of even a few hours, suffices to work wondrous changes in a body almost spiritual in its texture.

Amid all these elements of confusion, where are we to seek for the law and the order which really underlie the phenomena? There is law and there is order. Each one of the myriad comets pursues a definite high road through space. It is in the province of the mathematician and the astronomer to ascertain by their joint labors what the path is for each comet. The astronomer directs his telescope to the comet, and he reads from the graduated circles attached to his telescope the precise point in the heavens where the comet is located. He repeats this observation a few nights later, he does it a third time, and his work is done. All the mathematician absolutely requires is to know the place of the comet accurately on three nights. He will no doubt be glad to accept further observations; they will help to eliminate the errors inseparable from such labors; they will enable him to obtain three places of the comet purged from all sources of uncertainty. The comet is then within his toils. He can determine the route which the comet is pursuing. He can by his calculations follow the comet in its movements through the profundity of space far beyond the penetration of the telescope. The telescope only watches the comet during a brief portion of its career, but the subtle eye of the mathematician seldom loses sight of a comet once detected. He watches it recede to its greatest distance; he knows when the comet begins to return; he sees how it gradually approaches the sun. He assigns the spot on the heavens where the comet is first to appear, and he tells the day and sometimes even the hour when the telescope will welcome the wanderer's return.

It has long been known that the highway of each comet is one of those graceful curves known to geometers as conic sections. The comets which appear only once sweep through our system in a curve which cannot be distinguished from a perfect parabola. The small but exceedingly interesting class of comets which return periodically revolve in the most beautiful of all curves—the ellipse. The supreme law of gravitation has ordained that the comets must follow a conic section whereof the sun lies at one of the foci. But subject to this imperative restriction the orbit of a comet may have every degree of variety. A comet may revolve in a path so small that it only requires three years to complete a revolution. Another comet moving in a much longer ellipse will require seventy-five years. There may be every intermediate gradation, and there are some cometary orbits so vast that the mighty journey cannot be accomplished in less than thousands of years, while there are others whose orbits stretch out to a distance so stupendous that we fail to follow them in their wanderings. The ellipses seem to be utterly interminable, and in language of mathematics we say that the orbit is parabolic.

In order to enunciate the first of the great modern discoveries which we are to consider to-night, it is necessary to associate with each comet a certain particular elliptic path lying in a particular plane with a particular position in that plane and with a particular magnitude. The comet is, in fact, to be identified by its path as its only permanent characteristic, for, though the comets may exist in myriads, yet no two comets follow the same course through space; such a contingency is too remote to be worthy of serious contemplation; it is, in fact, infinitely improbable.

There is not, I believe, a greater surprise in the whole of modern astronomy than the discovery of a myriad of small bodies stealthily accompanying a comet in its mighty journey, and the surprise is all the greater when we consider that in another aspect we have been long familiar with these small bodies, and we have called them shooting stars or luminous meteors. It was Schiaparelli who first demonstrated, in 1866, the wholly unlooked for connection between the showers of shooting stars and the movements of comets.

Every one is familiar with the very beautiful spectacle of a shooting star, which is seen to flash into the air and vanish in a streak of splendor. These little bodies were long an enigma in astronomy, but they have gradually been subordinated to law and order. It has been found that the sun which controls the mighty Jupiter does not disdain to guide with equal care the tiny shooting stars, and their movements are now tolerably well known. The received doctrine about the shooting stars has stood the severest test known to science,- that is, the test of fulfilled prediction. The first great prediction in this refined branch of astronomy was made about twenty years ago. It was foretold that a splendid shower of shooting stars would occur on the night of November 12, 1866. All the world knows how triumphantly this prediction was fulfilled.

If I may be permitted, I would wish to narrate in a few words my own experience of that ever memorable night. The details of that majestic spectacle have been engraved on on my memory. I have had the good fortune to see other striking astronomical phenomena. The first was the glorious comet of 1858, the last was the transit of Venus in 1882; but I have no hesitation in saying that no phenomenon I have ever seen in the heavens, and no spectacle that I have ever witnessed on the earth, has impressed me so deeply and so profoundly as the great shower of shooting stars in 1866.

I was at that time astronomer to the late Earl of Rosse, at Parsonstown, and in the autumn of the year I attended my first meeting of the British Association at Nottingham. From the lips of my esteemed friend, Mr. James Glaisher, I learned that a great shooting star shower was to be anticipated on the 12th of November. The prediction could not be put forward with all the confidence that we have when the almanac foretells an eclipse. It was rather a venture, by which an important theory was to be put to a severe test.

On the ever-memorable night I was occupied as usual in observing nebulæ with the present Earl of Rosse at the great reflecting telescope. In the early part of the evening the sky was clear, and the night was dark; but no unusual phenomenon occurred until about ten o'clock. I was at that moment watching a nebula at the eye-piece, when I was startled by an exclamation from the assistant by my side. I looked up just in time to see a superb shooting star stream across the heavens. Soon came another star, and then another, and then in twos and in threes. We saw at once that the prediction was about to be verified. We ceased the observations with the telescope and ascended to the top of the wall, which forms one of the supports of the great telescope. This position commanded an extensive view of the heavens, and from it Lord Rosse and myself, on a beautiful starlight night, witnessed that gorgeous display of celestial fireworks which has given fresh impetus to astronomy.

It was not merely the incredible number of the shooting stars that was remarkable. They came no doubt in thousands which no man could number, but what was especially to be noticed was the intrinsic brilliancy of each individual star. There were innumerable meteors that night, any one of which would have elicited a note of admiration on any ordinary occasion. As the night wore on and the constellation of Leo climbed up from the east, then the display exhibited a very interesting and characteristic feature, for, as each shooting star was projected across the sky, the track which it followed was invariably directed from the constellation of Leo, nay, even from a particular point in that constellation. So marked a property of the shower suggests an appropriate name, and accordingly this particular group of shooting stars bears the not unpleasing name of the "Leonids."

It is easy to demonstrate that the apparent radiation of the meteors from a point is only the effect of a perspective. They are really moving in parallel lines. Those parallel lines have a vanishing point, and that point is the radiant in the constellation of Leo. As we stood on the walls of the great telescope, we saw the true character of the radiant most beautifully demonstrated. Those meteors which appeared close to the radiant pursued a track which was greatly foreshortened. A few that were actually at the radiant, or very close to it, had no visible track at all; they merely shone like a very rapidly variable star, which rose from invisibility to brilliancy, and then again declined to evanescence, all within the space of a very few seconds. In these exceptional cases we viewed the track of the stars "end on." They were, in fact, coming straight at us, but fortunately there was a kindly screen which shielded the earth that night from the awful meteoric tempest. Each one of those meteors hurries along with a velocity truly appalling; it is more than a hundred times swifter than the swiftest bullet that was ever fired from a rifle. It is really the demoniacal impetuosity of this velocity which is the source of the earth's safety. The meteor moving freely through space suddenly plunges into our atmosphere. Instantly a gigantic resisting force is aroused. The velocity of the meteor is checked, and the energy stored in that velocity is transformed into heat. That heat is enough to raise the body red hot, to raise it white hot, nay, even to drive the solid mass into a streak of harmless vapor. Of all the countless myriads of shooting stars which went to their destruction on that night, not one single particle has ever been recovered. These facts, when placed in the crucible of the mathematician, conduct him to a solution of the problem as to the nature of the great shooting star shower. It is to be remembered that the law of gravitation determines the movements of these bodies. The meteor, ere its disastrous collision with our atmosphere, must have been traversing the solitudes of space in an elliptic path with the sun in one of the foci. This is as true of a meteor the size of a grain of sand as it is of the earth or the planet Jupiter. The astronomer then approaches the question with the knowledge that the orbit of the meteors is an ellipse (or at all events one of the conic sections), but what the particular ellipse is must be decided by an appeal to the actual observations. The facts are simple enough: We note in the first place that the shower took place on the 12th of November, but on the 12th of November in each year, or on any other fixed date, the earth is always at a particular point of its annual journey round the sun. The stream of meteors must therefore pass through that particular point of space, and hence the search for the orbit is narrowed, for only ellipses which pass through this particular point can fulfill the conditions of the question. Another clew is afforded by the position of that point in Leo from which all the meteors seemed to radiate. The mathematician sees how to fit the ellipse so that it shall give the proper radiant. And now the question has been narrowed almost to the last point. One more appeal to observation, and the ellipse will be absolutely known. All we must now learn is how long the swarm of meteors takes to complete the circuit of its mighty path. To answer this question, profound historical research has been made by Professor Newton, and a mathematical research has been made which has given additional luster even to the name of Adams. The great showers of meteors have been shown to have occurred at intervals for the last thousand years. The earliest record was in the year 902, on the occasion of the death of the Moorish king Ibrahim-bin-Ahmad. An old chronicler describes how the event was solemnized in the heavens no less than on the earth; he tells us how "that night there were seen as it were lances, an infinite number of stars which scattered themselves like rain to right and left, and that year was called the year of the stars." We now know that this exhibition was not, as the old chronicler thought, a miraculous compliment to the memory of the deceased prince; it was really only a shower of the Leonids, such a shower as appears every thirty-three years, such a shower as appeared in 1866, such a shower as may be anticipated in the year 1899.

By these researches the path followed by the Leonids has been completely determined. The plane of the ellipse, and every circumstance of its position, and its proportions have been reduced to numerical accuracy. The shoal of meteors pursue their path unseen by any astronomer, but the mathematician knows precisely where they are at this moment, and at every moment.

This point being gained, a great discovery was made by Schiaparelli in 1866. About that time a comet was seen, this comet was duly observed, and the path which it followed was computed. There was nothing very remarkable about the comet, and it would not now be much remembered save for one most extraordinary circumstance, which Schiaparelli was the first to proclaim. Like the shoal of meteors, this comet also revolves in an elliptic path around the sun. This is a mere consequence of the law of gravitation, and calls for no remark, but the fact that the two ellipses lie in the same plane is a very remarkable coincidence which could not be overlooked. When we further come to see that the two ellipses are of the same size and shape, when we see that they are placed in the same position, when we see, in fact, that the ellipse which is the orbit of the shooting stars is identical with the orbit of the comet, then we have obtained a result which ranks as one of the most striking astronomical discoveries that this century has witnessed.

The Leonids therefore travel through space precisely in the track of the comet of 1866. The question at once arises of the relation of the shoal of meteors to the comet. Is the shoal of meteors one thing and the comet another thing, and do both these things happen to be traveling in the same orbit without any necessary connection, or are we to suppose that the two objects, if not actually identical, are at all events very intimately connected? These are problems which, in the present state of our knowledge, it seems difficult to solve. I shall only lay down one or two principles which may help us to form a conclusion.

Whatever be the nature of comets, or the materials of which they are composed, whether they be faint or bright, large or small, periodic or parabolic, one fact is certain, their masses are all extremely small in comparison with their great dimensions. I shall indeed, at a later part of this lecture, show that comets seem to be almost imponderable when compared with the great masses of the sun and of the planets. The great bulk of a comet necessarily implies that many parts of it are at a considerable distance from its center of mass. Hence for a double reason the coherence of the parts of a comet arising from their mutual gravitation is an extremely feeble force. Each particle of the comet is directly solicited by the sun to pursue a path of its own, and if the forces of coherence be not adequate to overcome this tendency, the comet must undergo a gradual degradation into separate parts. As the periodic time of the orbit of each part will vary, it will follow that the comet will be spread out in fragments along its path. It would seem that these small fragments constitute the meteors.

It is often supposed that meteorites, or solid bodies which actually tumble down on the earth, are connected with shooting stars, and hence it has been asserted, and even by very good authority, that meteorites are connected with comets, if not actually parts of comets. I merely mention this view for the purpose of saying that to me it seems quite unsupported by the facts. There is no reliable evidence, or indeed no evidence at all, that meteorites are connected with the periodic showers of shooting stars which alone are connected with the comets. This would not be the occasion to discuss the interesting question as to the origin of meteorites, but all the available facts seem to me to point to an origin on some body far more closely resembling a planet than a comet. It is now about sixteen years since Dr. Huggins first turned his spectroscope upon these bodies, and showed that certain lines in the spectra of the comet of 1868 were identical with certain of the lines of carbon. Since then many comets have been observed and much valuable spectroscopic work has been done. This has been so often and so fully discussed that I do not now propose to dwell on the subject at length. It is, however, quite impossible to avoid a brief reference to one of the latest efforts of Dr. Huggins' marvelous skill. He has succeeded in inducing a comet to depict with absolute fidelity its spectrum on the photographic plate. That photograph has not only shown the lines which could be *seen* with the spectroscope, but it has also exhibited many other lines in the invisible part of the spectrum. The discussion of this photograph and of the bright lines and the dark lines it contains is full of interest, though here I shall only remark that it contains convincing evidence of the presence of carbon in this comet.

That a comet's tail should be directed away from the sun is a very remarkable and characteristic feature of this group of bodies. At the first glance it seems at variance with every received doctrine of astronomy. The great law of nature which regulates the movements of the heavenly bodies is the law of attraction. The very movement of a comet in an elliptic path around the sun is in itself a demonstration that the comet is attracted by the sun.

While the comet as a whole is amenable to the law of gravitation, it is obvious that the materials, whatever they may be, which constitute the tail of the comet must be repelled by some force of an exceptional character. This force must sometimes be of very great intensity. Cases are not wanting where a comet, after darting in close to the sun, has actually whirled round the sun, with the stupendous velocity of 300 miles a second, and in a few hours has commenced its outward journey. During this appalling swoop what has been the conduct of the tail of the comet? It seems necessary to believe that at the commencement the tail was streaming away for millions of miles on one side of the sun, while in a few hours the tail has gone completely round, so as to be extending for millions of miles in the opposite direction. No known laws of mechanics allow us to believe that the *same* tail is seen under circumstances so diverse. We are compelled to believe that the tail is constantly dissipated and constantly renewed. It would, in fact, seem that the tail of a comet was in some respects like the column of smoke ascending from a chimney—the column remains, but the particles of which that column consists are in perpetual transition.

In the study of this subject we have to make use of the interesting labors of Prof. Bredichin of Moscow. This accomplished astronomer has devoted himself for many years to the collection and to the discussion of all the known phenomena of comets' tails, and he has succeeded, I believe, in taking a considerable step in the solution of the problems involved. In the first place, he has shown that there are different types of comets, and he has proceeded to classify them. There are, first of all, the comets with very long and very straight tails, such, for instance, as the comet of 1874, and many others. The next class included the tails of a scimiter shape. These are often of very great splendor, though not so long or so straight as those of the first type. The great comet of 1858 may be cited as an illustration of this class. The third and last class of comets' tails are very short and curved. It is to be observed that these tails sometimes exist in combination, so that a comet is often decorated with two tails of different type.

Once the form of the tail has been laid down, and the perihelion distance of the comet given, then the investigation of the forces adequate to the production of that tail is a problem admitting of numerical solution. It can be demonstrated that the straightest tail that ever streamed from a comet could be produced by a repulsive force not more than twelve times as great as the intensity of gravitation at the same distance. This number twelve will be the characteristic of tails of the first type. The tails of the second type vary within certain limits, but speaking generally, the repulsive force adequate to their production need not be more than about equal to the force of gravitation itself. The tails of the third type would be explained if the repulsive force were only the fifth part of gravity.

The next question that arises is as to the physical explanation of the repulsive force which produces these tails. We have to find this force of three different intensities, one about twelve times as great as gravity, one about equal to gravity, and one about a fifth of gravity. Before we postulate the existence of a new force of some unknown character, it is surely our duty to inquire whether there may not be some force already known which is competent to produce the phenomena. The best known repulsive force is of course that with which every one is familiar in connection with electricity. Electricity attracts electricity of an opposite type, while it repels that of the same type. We are also aware that in some mysterious manner the sun is connected with electricity. We know that the phenomena of terrestrial magnetism are connected with solar phenomena, and hence we are tempted to inquire whether the electricity of the sun may not offer an adequate explanation of the phenomenon of the comet's tail.

Let us suppose that the sun is attracting a distant body by virtue of gravitation, and at the same time repelling that body in virtue of the fact that the sun and the body are both charged with electricity of the same name. When the attracted body is one of large dimensions, the attraction will vastly exceed the repulsion, and indeed the latter may be entirely neglected in most cases. There is, however, a radical difference between the nature of the electrical forces and the nature of the gravitational forces. The latter are proportional to the masses of the attracting bodies, while the electrical forces are proportional to their surfaces. The mass varies as the cube of the linear measurements, while the surface only varies as the square. The relative efficiency of the electric repulsion in comparison with the gravitational attraction increases as the radius of the particle decreases. It must thus necessarily follow that no matter how great may be the preponderance of the power of gravitation on masses of finite dimensions, yet it must always be possible, other things being equal, to have a particle so small that the electrical repulsion shall exceed in any required ratio the intensity of the attraction of gravitation.

As the comet draws near the sun, the heat it experiences increases, so that the materials of the comet begin to dilate, and to be driven off into a vaporous condition. The matter is thus resolved into a state of extreme subdivision. These separate particles are charged with an electricity similar to that of the sun, and in virtue of their minuteness the intensity of that repulsion has become sufficient to sweep off the particles in a stream, and thus generate the tail.

Such is the modern view of the formation of comets' tails. Professor Bredichin has given good reasons for thinking that we can even discover the special ingredients which enter into the formation of each of the three types of tail. It seems, from the molecular nature of hydrogen, that this element is especially suitable for the tails of the first type. The tails of the second type seem to arise from some substances possessing the properties of hydrocarbons, while the tails of the third type contain some elements which seem to have a high atomic weight. The theory of Professor Bredichin is well illustrated by the comet of 1858. This comet, besides the majestic curved tail, the object of so much admiration, had a pair of long, faint, slender tails, streaming straight from the head. These two objects were doubtless the edges of a conical tail of the first type, too faint to be visible throughout its entire extent. The great tail was one of the second type.

We have many reasons for believing that the masses of comets are very much less than the masses of the planets. We might indeed almost conclude that the masses of the comets are inappreciable. Let us briefly indicate the grounds for this important conclusion.

The sun and the planets form a system characterized by perfect order and symmetry. We have the sun in the center. We have all the great planets moving round the sun in the same direction. They all move nearly in circles, and all these circles lie nearly in the same plane. This organization is a necessary *modus vivendi* among the bodies of our system. Each planet acts and reacts upon all the other planets, but, owing to the circumstances of their movements, their irregularities are but small, and the permanence of the system is insured. Alter that system to any extent, merely reverse for example the direction in which one of the planets is moving, and the whole compromise is destroyed. The actions and reactions, instead of being quickly balanced, will go on accumulating, and the seeds of confusion and ultimate dissolution have been sown. But we have in our system thousands of comets which repudiate all the regulations by which the planetary convention is restrained. Comets come in what direction they please, they move in every plane but the right one, and their orbits are not in the least like circles. The very fact that our earth continues to revolve around the sun so as to be a fit abode for life is a proof that comets cannot have any considerable mass. If comets had mass, then organic disease would be introduced into the solar system, which must ultimately prove fatal.

Science has gradually dissipated the fears which once invested comets; they are interesting and beautiful visitors which come to please and instruct, never to threaten or to destroy.

HOT WATER FOR SPRAINS.

FOR sprains, Prof. Brinton teaches that the limb is to be put into a vessel of very hot water immediately, boiling water being added as it can be borne, and kept immersed for twenty minutes or until the pain ceases. Then put on a pretty tight bandage, and order rest. Sometimes the joint can be used in twelve hours. If the trouble is more chronic, apply a silicate of sodium dressing, and let the patient walk with a cane, if the ankle be the joint affected.—*Col. and Clin. Record.*

SLEEPLESSNESS.

OF the new hypnotic the *Medical Press* says: Paraldehyde is claiming the attention of the profession, as in some respects it is superior to chloral, as it is very safe to give in simple sleeplessness, and leaves no unpleasant after-effects. However, it is of no use where insomnolency is the result of pain. It is given in the following formula:

Paraldehyde................................ ʒ j.
Syrup of orange............................ ℥ j.
Water...................................... ℥ j.

To be taken at bedtime.

—*Louv. Med. News.*

BEER CAUSES BRIGHT'S DISEASE.

MOST physicians of fifty years ago, or more, are familiar with the fact that a generation ago Bright's disease was rare; now it is one of the most familiar causes of death. Every day's paper contains the names of its victims. The reason for this is manifest; it is the pernicious and foolish habit of daily indulging in beer drinking.—*Gaillard's Med. Jour.*

A CATALOGUE containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

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